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(*Supplement to the Journal of the Council for Scientific and Industrial Research, February*, 1939.)

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5. Wheat-Storage Problems (Damaged Grain and Insect Pests). (Out of print.)
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64. Soil Drift in the Arid Pastoral Areas of South Australia.
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1. Sound Practice in the Air Seasoning of Boards. (Revised Edition.)
2. The Testing of Timbers for Moisture Content. (Revised Edition.)
3. The Growth and Structure of Wood. (Revised Edition.)
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The Catalogue of Scientific and Technical Periodicals in the Libraries of Australia (1930). [Price 10s., post free.]

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Circular No. 1—P. "The Commercial Ripening of Bananas."

"C.S.I.R.—Ten Years of Progress 1926-1936" (A popular account of the Council's work during its first ten years of existence).

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The National Standards Laboratory—Its Relation to Commerce, Industry, and Science.

By G. Lightfoot, M.A.

(From a paper read before the Institute of Public Administration—Victorian Regional Group, on the 20th October, 1938.)

1. The Functions of a National Standards Laboratory.

A National Standards Laboratory is, of course, only a means to an end, and a mere description of the work and organization of the laboratory itself—a subject which would be concerned largely with technical details—would not contribute to an adequate appreciation of the ultimate objects of establishing the laboratory, and of its importance to the commercial, industrial, and scientific activities of the Commonwealth.

It is therefore proposed to give a picture of the position from a somewhat wide angle and to outline in a general manner the functions of a National Standards Laboratory, and then to show how its work and the national standards which it will maintain will permeate through other institutions and organizations to the everyday transactions and activities of the community and to the efficient development of our industries. The application of national standards to meet the requirements of commerce, industry, and science will be effected in three main directions, viz.—

(*a*) through the control of commercial standards, i.e., what are generally known as weights and measures;

(*b*) through the testing and calibration of instruments and apparatus used in industry and in scientific work; and

(*c*) through tests to show that materials comply with the terms of standard specifications published by the national standards authority for the Commonwealth, viz., the Standards Association of Australia.

Under the Constitution Act the Commonwealth has power to legislate with respect to weights and measures, though it has not yet exercised that power. If the term "measures" be interpreted in its broadest sense, it will cover measures of all the physical quantities with which commerce, industry, and science are concerned. Under British legislation, the term "measuring instruments" is defined as including any instruments for the measurement of length, capacity, volume, temperature, pressure, area, counting, and for the measurement and determination of electrical quantities and of heat and light.

It is obviously no exaggeration to say that there are very few of our daily operations into which these standards do not enter either

directly or indirectly. They are necessary for the purchase and sale of nearly all our daily requirements, for the measurement of all sorts of operations in manufacturing industries, for the sale of land, for surveys, for the measurement of gas, water, wood, coal, petrol, and electricity, for meteorological and astronomical observations, and for the sale over the counter of innumerable materials by measure of weight, length, area, or volume.

Moreover, accurate measurements are now essential for efficient and economic methods of production in very many industries. By the careful control, that is, by measurements of one kind or another of all the processes of manufacture, not only is the cost per unit decreased, but the quality of the product is improved. This may be control of temperature, humidity, density, pressure, and so on, and such control can be obtained only by the use of measuring instruments. In order that the measurements may be accurate, obviously the instruments themselves must be accurate, and this cannot be ensured unless provision is made for testing or calibrating them periodically, i.e., comparing them with instruments of a known higher degree of accuracy.

Frequently, interchangeability of parts is essential. In other countries it is not uncommon to find individual firms operating in the production of certain components, but, in mass production, individual fitting is a thing of the past. Any one of thousands of components of one kind must be a true and satisfactory working fit with any one of a similar number of other components. This is only possible if manufacture is controlled within very fine limits of accuracy, and this can be achieved only by the use of carefully designed and accurately made gauges.

Obviously, scientific workers must be provided with measuring instruments of a very high degree of accuracy. We see, therefore, that our commercial requirements, the efficient development of industries and accurate determinations in scientific work, all necessitate the maintenance of national reference standards with which the sub-standards can be periodically calibrated or checked. It is the function of a National Standards Laboratory to maintain these standards and to provide facilities for comparing sub-standards with them.

Before national standards can legally be brought into operation in Australia two things are necessary. Firstly, Commonwealth legislation will have to be passed, and secondly, the necessary national standards will have to be acquired and maintained. As regards the former the Commonwealth Act will have—

(*a*) to define the legal standards for the Commonwealth and to adopt those standards which are legalized in Great Britain;

(*b*) to authorize the necessary fundamental and derived standards to be acquired and preserved;

(*c*) to provide that all sales and purchases made in the Commonwealth by weight or measurement of a kind for which Commonwealth standards are provided shall be made in terms of the units defined by such standards;

(*d*) to provide that every weight or measure which is required by law to be verified in the Commonwealth shall be verified in terms of the Commonwealth standards.

Under the Science and Industry Research Act, by which the Council for Scientific and Industrial Research was established, one of the functions of the Council is the testing and standardization of scientific instruments and the carrying out of scientific investigations connected with the standardization of apparatus, machinery, and instruments used in industry. The Council is therefore the appropriate body to be entrusted with the maintenance of our national standards of measurement, and it has accordingly been directed by the Commonwealth Government to establish a National Standards Laboratory for that purpose.

The first steps taken by the Council for the establishment of a National Standards Laboratory were to secure a site for the Laboratory in the grounds of the University of Sydney, and to appoint three highly qualified officers, one to take charge of each of the three main Sections of the Laboratory, viz., (1) Metrology, (2) Electrical, and (3) Physics. These three officers will probably have to spend some time at the National Physical Laboratory, England, which has undertaken to assist in obtaining all the standard equipment necessary. A careful specification will have to be drawn up for each piece of apparatus, the orders will have to be placed, and then, when delivered, the Australian standards will have to be calibrated with the British standards. All this will involve a considerable amount of time, and it is not anticipated that the Laboratory will be ready for at least two years. It is estimated that the capital cost of the building and its equipment will be initially from £80,000 to £100,000.

The question of establishing national standards and of maintaining them is by no means the simple matter which it is sometimes thought to be. It is not sufficient merely to procure standards and to deposit them securely in some form of vault. If the standards are to serve a useful purpose, provision must of course be made for comparing them with sub-standards with which, in turn, working copies may be compared and corrected. To do this work, proper facilities are required, and in many cases it will be found that the auxiliary equipment which is necessary will be many times more expensive than the standards themselves.

It should be understood that it will not ordinarily be the function of the National Standards Laboratory to carry out the routine work of calibrating instruments used in industry. It will calibrate the high precision sub-standards with which working standards will be checked in other testing stations. It will also have to render assistance in the establishment of testing laboratories in the several States, to certify the sub-standards maintained by these laboratories, and to advise as to testing instruments and apparatus and as to methods of test in order to effect co-ordination throughout the Commonwealth. The National Laboratory will have to be in a position to provide certified standards and measuring instruments which will be established in these testing laboratories and with which master standards used for commercial, industrial, and scientific purposes can be checked. Further reference to this matter of calibration will be made later.

2. The Three Main Sections of the Laboratory.

The three main Sections of the Laboratory will have to collaborate closely with respect to certain fields of work. Their main functions will be as follows:—

(i) *The Metrology Section* will be the custodian of our national standard units of mass, length, and time. These are generally known as fundamental units because, theoretically at any rate, it is possible to derive most of the other units from them. In some cases, however, practical difficulties arise which make it necessary to specify units of some quantities arbitrarily. This applies to such units as temperature, candle power, and electrical units.

In addition to being responsible for measurements of the primary quantities length, mass, and time, the Metrology Section will also maintain the more direct derivatives such as area, volume, density, pressure, &c. It will have to provide for the accurate calibration of yard and metre scales (and also, of course, of scales giving fractions or multiples of the yard and metre), weights and balances, surveying tapes, high precision engineers' gauges of all sorts, measuring machines, screws, micrometers, surface plates, straight edges, &c.; in short, of any length measure or apparatus for length measurement. Apparatus for area measurement, such as planimeters, will have to be calibrated.

Volume measurement will include the calibration of volumetric glassware used for chemical analyses. Provision will have to be made for the accurate checking of apparatus such as hydrometers, barometers, balances, &c. The calibration of master standards for engineers' gauges will be a most important part of the work of this Section and will be referred to later.

(ii) *The Electrical Section* will have charge of the Australian legal electrical standards—the ampere, the unit of intensity of electric current; the volt, the unit of electromotive force; and the ohm, the unit of resistance. The units at present employed in electrical measurements are the International units defined in 1908. They are at present defined in terms of material standards. Thus the standard unit of electric current is determined by the weight of pure silver deposited under strictly defined conditions, and the unit of electrical resistance is based on the resistance of pure mercury to the flow of electricity. These units will, however, before long be displaced by a system of absolute units expressed in terms of the fundamental units of length, mass, and time. In addition to the three primary electrical standards, a number of secondary standards will be required for the measurement of derived electrical quantities—capacity, inductance, &c.

The Electrical Section will, of course, be responsible for the calibration of electrical measuring sub-standards of all kinds—ammeters, voltmeters, wattmeters, supply meters, resistances, shunts, fuses, &c., all of which are necessary for the measured control of electricity used in our daily domestic, commercial, and industrial activities.

(iii) *The Physics Section* will deal with standards of heat, light, and sound. It will have to carry out tests of all classes of instruments for measuring and recording temperature, e.g., clinical thermometers, electrical resistance thermometers, thermo-couples, and optical and total radiation pyrometers. It will be responsible for maintaining the

standards of illumination for Australia. The standard of light is known as the International Candle, and is maintained by the periodical inter-comparison of sets of standard lamps preserved at the various national laboratories. The Section will be responsible for determining the candle-power of different sources of light, e.g., electric lamps, gas lamps, motor-car headlights, life tests of electric lights, &c. As regards acoustics, there have been very important developments in recent years and the subject has become of great importance in many directions. Much attention has been given to problems of architectural acoustics, and experimental methods have been devised for exploring fully the acoustic characteristics of large halls. The Section will later no doubt be called upon to determine the sound-absorbing properties of building materials, to make measurements of sound intensity and of frequency and purity. Investigations will have to be made into means for reducing noise in special instances, e.g., in buildings in connexion with running machinery and also traffic noises. This will necessitate the development of a special acoustics laboratory.

One or two examples of the intricacy and the tedious and highly technical nature of the work may be given. The British standard yard is a solid bronze bar of square cross section on which are engraved fine lines. The measure of length is given by the interval between a particular pair of these lines at a temperature of 62°F. Copies of the Imperial standard yard are deposited with the Royal Mint, the Royal Society, the Royal Observatory, and the Board of Trade. These are known as Parliamentary copies. In 1936, the results of exhaustive investigations on the standard yard were published. They show that the yard cannot be regarded as definitely established to a precision of more than one part in a million. The British Board of Trade states that this is definitely inferior to the precision attainable with modern standards and to the current needs of science and industry. It clearly calls for the introduction of a new standard in the endeavour to obtain more permanent and accurate standards. Efforts have been made to obtain a natural method of control, e.g., in terms of the wave-length of some particular kind of light. The comparison of the four Parliamentary standard yards with the British standard involved 16,000 microscope readings and 4,800 thermometer readings, and occupied the time of three observers for over a month.

Although length is one of the simplest kinds of measurements, even so simple a test as that of a steel tape calls for carefully planned procedure and elaborate equipment. Metal measuring tapes are used by the surveyor, engineer, and builder to measure land and in grading and construction works. Errors in tapes cause disputes or mistakes. The National Standards Laboratory will have to be equipped with a tape-testing tunnel—probably about 150 feet long, with means to cool or heat it in order to duplicate the range of temperatures at which tapes are used. The tunnel will have to be provided with a set of thermometers, microscopes, tension balances, and micrometers. The metal tapes expand with heat; hence the calibration is correct only if the thermometer is accurate. The length of tape is specified for a certain tension measured by a spring balance. The checking of the tape is again futile unless the balance is correct. Both the balance and the thermometer must therefore themselves have been carefully calibrated.

3. Commercial Standards—Weights and Measures.

The ordinary commercial standards commonly known as weights and measures are at present controlled by the respective States. The Weights and Measures Acts of the different States differ considerably, though they all adopt the fundamental British units. The Commonwealth Government could, if it desired to do so, take over complete control throughout Australia of the administration of weights and measures, or it could arrange for the administration to be carried out through the States. The former is the method adopted in Canada where it has proved to be effective and economical, and has enabled uniformity throughout the Dominion to be secured without difficulty. The latter method has been adopted in the United States of America where, although the Federal Government has power to control weights and measures, it has been content merely to define certain of the units and has left it to the 48 States to prescribe their own Regulations. The United States Bureau of Standards has faced the difficult task of attempting to co-ordinate the work of the States with the object of obtaining uniformity. To-day, although 26 annual Conferences of Federal and State weights and measures officials have been held for the purpose of securing uniformity, the position still remains unsatisfactory.

It appears likely that conditions in Australia could best be met by Regulations prescribed under a Commonwealth Weights and Measures Act, and that the necessary authority for the enforcement of such Regulations could advantageously be delegated to the individual States. Such a system would remove practically all the disadvantages which exist under the present arrangements in the United States, and at the same time would not interfere with the organizations which have already been developed in the individual States for carrying out such work. In this connexion, it may be pointed out that, at the Conference of Commonwealth and State Ministers held at Adelaide in August, 1936, a resolution was passed to the effect that if the Commonwealth enacts legislation covering the establishment and maintenance of Commonwealth standards of weights and measures, the States will fully co-operate in regard to the uniform adoption throughout Australia of such standards.

The administration of commercial standards is not a matter which concerns the Council for Scientific and Industrial Research, though the Council must necessarily enter into the picture, inasmuch as it will be its duty to attend to the periodic calibration and checking of the sub-standards which have to be kept by the States. It is proposed that provision for this should be made in the Commonwealth Act.

4. The Calibration of Measuring Instruments.

The second main line of industrial application of the national standards relates to the calibration of all sorts of measuring instruments—mechanical and electrical—used for industrial and scientific purposes.

Gauges and measuring devices are, of course, subject to changes with time and use, and must, therefore, be calibrated periodically. For such purposes a factory requires to have master gauges with which the working gauges used in the shops can be checked. These master

gauges must, however, in turn be periodically calibrated against gauges and instruments of a still higher degree of accuracy. These are called sub-standards, and the accuracy of these must again from time to time be checked with the primary reference standards maintained at the National Standards Laboratory.

The range of equipment from primary standards down to working gauges is necessarily intensive. At the top of the range is the costly and very accurate equipment which must be housed and handled with every possible precaution against injury and against temperature and other influences which would impair its accuracy. At the other end are the working gauges which are much less accurate and much less costly and are constantly in use. In normal precision manufacture the working gauges should measure to one thousandth of an inch. The master gauges for checking these must measure to one ten thousandth of an inch. The sub-standards for checking the master gauges must be accurate to one hundred thousandth, and the national standards to one millionth of an inch.

The establishment of an effective system for the calibration of gauges is a matter of real importance to Australia. The position in this country at present is little short of chaotic, not because of any lack of efficiency on the part of the Australian manufacturer, but because he is not afforded the gauging and calibration facilities which can be given only by those in authority. There can be no assurance under present conditions that components made in different factories will fit together with precision, because the master gauges in those factories are not calibrated at a common source, and, therefore, cannot agree with each other. In view of the projected developments in relation to aircraft and motor-car engine manufacture, and the increasing activity in precision manufacture of various forms, the establishment of a National Standards Laboratory and an effective calibration service must be regarded as a matter of urgency.

The preceding remarks relate to requirements with regard to measurement of length. A very similar position exists in relation to other units of measurement. Certain derived units require standards for convenient calibration. For example, the units of volumetric measurement are reduced finally to units of length in three dimensions, but it is convenient to hold actual standard measures of volume in preference to calibrating all volume measuring apparatus from linear measurements. Again, with regard to electrical units, there is an urgent need for reference standards, including those for derived electrical quantities. The principal electrical laboratories in Australia have encountered serious difficulties by reason of the lack of authoritative standards in Australia, such for example as standard cells, by which the accuracy of their own laboratory standard cells can be checked. As a precautionary measure, they have in some cases adopted the practice of regular inter-comparison of their standards, but no assurance as to the results of such comparisons can be felt. When it is realized that there are vast numbers of electrical measuring instruments used in Australia, which form the basis for many determinations, both technical and financial, and that there is no authoritative court of appeal in Australia as to the accuracy for those instruments, the importance of establishing national reference electrical standards in Australia is obvious.

In relation to optics and thermometry, both of which affect a number of important industries, a similar state of affairs exists, with a corresponding need for national reference standards.

In other countries, e.g., England, United States, and Germany, National Standards Laboratories maintain the standards and carry out the calibration of sub-standards submitted to them. The sub-standards which pass the tests are marked with national test marks registered under the Trade Mark Act, but the calibration of most standards used in industry and for other purposes is generally carried out either by the makers of the instruments themselves, or by one or other of the numerous testing houses which have been established.

In Australia, however, little has been done in the direction of establishing testing houses, and the manufacture of scientific instruments is as yet in its early infancy. There remains, therefore, much to be done in this direction. Many State Departments such as Works Departments, Railways Departments, Electricity Commissions, &c., and several of the Departments at the State Universities possess testing facilities of one sort or another. A proper co-ordination of the work of these bodies and of the facilities available at them would make it possible to devise means whereby copies of the national standards and units could be established in different centres, and the proper calibration of instruments and apparatus used in industry could be maintained. The aim of the Council in this matter will, therefore, be to secure the co-operation of various authorities in the several States and gradually to build up the necessary facilities.

It is proposed that the Council's Act and Regulations should be amended so as to enable the Council to acquire the sole right to control the use of prescribed marks as national test marks. These marks would be applied to sub-standards calibrated at the National Standards Laboratory, but they would also be applied by approved State testing laboratories which possess sub-standards calibrated with the national standards. In this way a body of co-ordinated and approved testing stations would be established under the authority of the National Standards Laboratory, thus ensuring uniformity throughout the Commonwealth. The development of a comprehensive plan of this nature will, of course, take several years to achieve.

5. The Testing of Materials for Quality or Performance.

Close relations will have to be maintained between the National Standards Laboratory and the Standards Association of Australia in connexion with tests to ensure that materials and articles comply with the provisions of standard specifications. These are tests for quality or performance and are, therefore, distinct from the measuring instrument calibration tests to which reference is made in the preceding paragraphs.

For some years past, standardization has been carried out by the Standards Association of Australia and similar bodies in other parts of the world. Nearly all large purchases are effected on the basis of a contract embodying a specification, and standard specifications published by national standardization authorities are now frequently used for that purpose. The specifications contain provisions as to quality or performance which must be complied with; tests of various kinds, mainly physical, chemical, and metallurgical, are necessary in order to determine compliance with the specified requirements.

Again, many industries are subject to regulations having as their purpose the safety of the public, the prevention of loss by fire and other hazards, and the effectiveness of public utility services. It is, therefore, common practice to require approval tests for electrical appliances, steam boiler equipment, crane and hoist gear, plumbing accessories, building materials, equipment used in mines and other hazardous locations, materials subject to Customs requirements and various other products and materials. The already large amount of testing under this category is increasing rapidly.

There are three main reasons for the creation of a national authority for the control of industrial and commercial testing—

(i) Whilst existing laboratories possess such equipment as has been found to be necessary for the particular purposes to be served by them, there is at present no authority charged with the responsibility of ensuring that all the testing needs of the community are met. Accordingly, there are many tests which cannot at present be carried out in Australia and for which there is a very pressing need.

For example, the textile industry, which is developing logically as an important branch of Australian manufacture, is one in which testing is displacing the old haphazard method of judgment of quality by feel and visual inspection. Hospitals and other public institutions are adopting standard specifications and tests to govern their purchasing.

Temperature and humidity control in the preparation of samples for testing is essential in order to avoid variable and therefore unreliable test results. This necessitates conditioning houses, in which atmospheric conditions can be controlled.

The expenditure on textiles by hospitals alone is very great, and replacements are a heavy item in maintenance costs. It is therefore important that there should be effective methods of determining the qualities of a fabric, such as durability to wear, fastness to light, shrinkage, &c. This can only be done satisfactorily by the application of suitable tests under recognized standard conditions.

Notwithstanding the importance of this function there are no conditioning houses in Australia and only quite inadequate textile testing machines. This deficiency will have to be rectified.

Another interesting example is afforded by Departmental regulations. For the safeguarding of human life in mines and other locations rendered hazardous by the presence of inflammable gases and vapours, it is required that electrical apparatus installed in such locations shall be of special construction, known as "flame-proof." A British standard specification defines a "flame-proof enclosure," and specifies the tests necessary to determine whether apparatus may safely be used in the presence of gases.

The manufacture of flame-proof electrical motors and equipment in Australia is established and is developing rapidly. There is, however, no testing equipment available to industry for testing for flame-proofness. It is beyond the capacity of most manufacturers to install their own testing plant, and it would not be sound economically to duplicate the installations when one plant could serve the present needs of Australia. It is, therefore, highly desirable that such an installation be provided as early as possible.

(ii) There is an urgent need for an organized testing service which will be recognized as quite impartial and whose certificate of test will

be mutually acceptable to purchaser and vendor. The routine testing of materials of construction furnishes an example. This covers a very wide range of testing and is a very necessary precaution, in order that faulty material may not impair the safety, stability, or performance of the structure or product. The need for an independent judgment frequently arises when the Department controlling a laboratory largely used for commercial testing happens also to be the purchaser of the material or product. In such cases the vendor justifiably desires to have the verdict of a disinterested party.

(iii) Australian industry is handicapped by the lack of a national testing authority whose certificate of test will be accepted without question by parties in all States of the Commonwealth and will be regarded as a hall-mark of approval.

An interesting example of the need for centralization of testing control is provided by the electrical industry. Because of the hazard attending the use of faulty electrical appliances and materials, there is a move in Australia to institute more rigid control over the sale of these products. In New South Wales and Victoria, recent legislation requires that all such articles should be submitted for test and approval. With the assistance of the Standards Association of Australia, a comprehensive range of standard tests is being prepared and adopted.

Other States already have some measure of control in these matters and are providing increased powers closely in conformity with those granted by the New South Wales and Victorian Acts. There is a desire on the part of the several State authorities to co-operate fully in these matters. Under present conditions, however, each product must be submitted for testing in each State, and this is an unnecessary annoyance and expense to manufacturers. The difficulties are accentuated when, as sometimes occurs, the State tests give conflicting results because of variable methods of operating the tests.

The State authorities would welcome a scheme of co-ordinated testing under which a certificate of test given by an authoritative central organization might with confidence be accepted throughout Australia.

For these reasons steps will have to be taken to organize a system of testing, in association with the control of the national reference standards, by a body whose status will carry recognition throughout the Commonwealth.

6. National Standard Marks.

Originally, the work of national bodies responsible for the preparation of standard specifications was confined to materials which were used in the engineering and allied industries and which were generally purchased in large quantities. In such cases the purchaser ordinarily had facilities—either in his own testing laboratory or by utilizing the services of a testing consultant—to satisfy himself that the materials complied with the terms of the specification. In other countries, for example, England, Germany, U.S.A., etc., legal protection has been given to national standard marks which are used with the authority, and under the control, of the national standardization bodies, in order to indicate that the materials or articles to which the mark is applied actually conform with the provisions of the relevant standard specifications.

In recent years the standardization movement has been extended to a large number of materials and products other than those urged by engineers, and pressure has come from consumers' organizations for standards for many sorts of commodities sold over the counter in small quantities. The public is, in fact, coming to demand certificates of quality guaranteed by an independent authority. It has needed and has obtained the protection of Weights and Measures Acts, but the time is past when standards of weight, length, and capacity are all that is required. The public now requires some guarantee of quality or performance which may mean very much more to him than mere weight or measure.

The testing of materials by the small purchaser is obviously generally impracticable. For example, he has no facilities for determining whether a fabric is all wool, or is unshrinkable, or will not fade, as may be stated on the label. He cannot determine whether an electric lamp is a good one or whether an electric appliance is safe. As a result, there is a growing demand for marks to be applied to indicate that the goods conform to a recognized standard.

In Australia, this matter is receiving the attention of the Council and the Standards Association. For some years past, no action has been taken mainly for the reason that the Commonwealth Trade Mark Act requires that a mark can be registered only if the authority or association applying for it undertakes the examination of the goods in respect of conditions of manufacture, quality, accuracy or other characteristics, and certifies the result of such examination. It would, of course, be quite impracticable for the Council or the Association to set up the organization which would be necessary in different parts of the Commonwealth, and to provide for the inspectorial staff and testing facilities which would be required, in order to enable it to examine and certify the goods to which a national mark might be applied as required by the Trade Marks Act.

Consideration is now being given to the question of amending the Act so as to permit of the registration of national standard marks for quality or performance in such a way that the administration and application of the marks can be controlled economically and effectively. If an amendment of the Act is secured, it is proposed to make a beginning in a small way with the application of national standard marks to certain commodities, and gradually to extend their use as the demand arises. As the use of the mark develops, a considerable amount of testing will, of course, be required, and the National Standards Laboratory will have to play an important part in seeing that the necessary facilities are available, and that testing instruments of one sort and another are calibrated with the national standards.

7. Public Relations.

The purpose of this paper is to present a picture of the functions of the National Standards Laboratory and to show how its works will be brought into intimate relation with the commercial, industrial, and scientific activities of the Commonwealth. In conclusion brief reference may be made to what may be termed the "public relations" of the National Standards Laboratory.

Firstly, as regards International and Imperial relations—by International Convention the highest tribunal on standards is the

International Bureau of Weights and Measures at Sèvres, near Paris. The work of that Bureau, which is the custodian of the International standards of mass, length, etc., is supervised by an International Commission on which Great Britain is represented. Australia will legally adopt the British Imperial Standards and will maintain intimate contact with the National Physical Laboratory in England and, through it, with the International Commission.

With the Commonwealth Government, the National Standards Laboratory will have intimate relations in many directions. The standard of length will control the steel tapes by which surveys are made. Coinage is based on weights derived from, and checked by, the unit of mass. For many of the Commonwealth Departments, the National Standards Laboratory will have to perform standardizing services for research apparatus and measuring instruments. It will be the final court of appeal in all standard matters within the Commonwealth.

The State Governments will have to depend on the National Standards Laboratory for standards of measurement and for testing them at intervals in order to keep them true to the national standards, particularly in connection with commercial weights and measures. Existing facilities in the States will have to be developed and co-ordinated so that they may be brought into line, and form part of a national scheme of testing in connection both with calibration tests of instruments and of tests for quality and performance. The State scientific and technical departments will have to rely on the National Standards Laboratory, through these State laboratories, for the checking of their measuring instruments.

Close relations will be maintained by the Standards Laboratory with the national engineering, industrial, and scientific associations and societies. In connection with the calibration of scientific instruments, contacts will be established with scientific institutions and with the State, University, and other testing authorities. The Laboratory will maintain close liaison with the Standards Association of Australia, by which it will be called upon for advice regarding methods of tests of quality and performance. These contacts must inevitably lead to the necessity for investigations into the properties of materials, particularly of Australian raw materials used in manufacturing processes. This has been the experience of national standards institutions in other countries, where, in addition to maintaining and calibrating standards, a vast amount of research work is conducted for the benefit of industry.

With the general public the relations of the National Standards Laboratory will be of great importance, though generally of an indirect nature. The individual will be the ultimate beneficiary of all its achievements. The efficiency of the service given by thousands of industrial products is determined by measurement of one sort or another, and the function of the National Standards Laboratory will be to diffuse precise values of all units of measurements on which such measured service is based.

8. Acknowledgments.

For information embodied in this paper, the writer is indebted to Mr. W. R. Hebblewhite, Chief Executive Officer of the Standards Association of Australia; Professor J. P. V. Madsen, University of Sydney; and Mr. E. L. Sayce, Senior Physicist, Munitions Supply Laboratories, Melbourne.

The "Blinker" Electrical Moisture Meter: Recent Modifications.

*By A. J. Thomas, Dip. For.**

Summary.

The "Blinker" electrical moisture meter for timber has been modified in the following ways. The 180 volt special battery has been replaced by a vibrator unit and two 1½ volt torch cells, parabolic mirrors have been included to make the glow of the lamps more easily seen, the cost of manufacture has been reduced by eliminating several individually-made condensers and incorporating resistors, the size and weight have been reduced, and a more convenient carrying case has been built.

Introduction.

The "Blinker" electrical moisture meter for timber, developed by Dunlap and Suits in the United States of America and introduced into Australia in late 1931 by the Division of Forest Products, has proved to be an extremely useful instrument, over two hundred now being in use here. These were made by a local manufacturer, Mr. W. R. Pullar, to a design developed by him in association with the Division of Forest Products, and they have proved highly satisfactory. Nevertheless, accumulated experience pointed out the desirability of the following improvements:—

1. Substitution of a power supply more convenient than the extra light duty 180 volt battery which had to be made to order, was expensive, and, owing to the small size of the cells, had a short life despite the fact that the actual current consumed by the neon lamps was negligible.
2. An increase in the visibility of the neon lamp in the test circuit at low moisture contents.
3. A reduction in manufacturing cost.
4. A reduction in weight and size.
5. Provision of a more convenient place for packing the hammer and leads.

During 1938, the Division of Forest Products commenced experiments and by July the first improvement had been successfully effected; by December the remainder had been accomplished. The outcome has been the introduction of a power supply unit for existing instruments and the development of a re-designed instrument for future manufacture.

Description of Modifications.

(i) *Power supply.*

A vibrator unit, somewhat similar to the units used in car radio sets, but working on three volts and having a low current consumption was developed in the laboratory. Several commercial firms were approached concerning manufacture, and one, Messrs. Techtron Appliances, undertook construction and effected several improvements which the author wishes to acknowledge. About 50 of these units are already in use.

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The unit consists of a specially designed transformer with centre-tapped primary and secondary, two synchronized four-volt vibrators specially tuned, one high frequency by-pass condenser, and two small condensers.

Operating from two 1½ dry cells of any size, e.g., torch cells or No. 6 bell-ringing cells, it delivers 180 volts direct current to the neon lamps. The current consumption ranges from 0.16 amps down to 0.12 amps according to whether the dry cells are delivering a full three volts or less. This is approximately half the consumption of an ordinary torch globe, so that it will be seen that two torch cells will have sufficiently long life to be suitable for incorporation in future instruments. Apart from the fact that the annual battery cost will be lower, there is a decided advantage in using these cells in that they are small and can be purchased anywhere.

The commercial unit is neatly assembled in a metal case designed to fit the battery compartment of existing instruments, leaving room for two large No. 6 dry cells if required. This feature may be seen in Plate 1, Fig. 1. Installation of the unit is very simple. The two wires which originally were connected to the 180 volt battery are clamped into the two terminals on the unit, and the two wires from the unit go to the dry cells, which are connected in series. The manufacturer supplies a diagram showing the proper positive and negative connexions.

(ii) *Increased visibility.*

The flash of the standard neon lamps is quite easy to see, but, if the timber being tested is drier than 13 per cent. moisture content, the glow of the test lamp is quite faint and very hard to see in bright light. One reason for this is that the discharge takes place from the wire in the lamp and not the plate and then only over a small length of the wire. A reflector has been developed which effects a marked improvement. It consists of a deep tube which is black except at the bottom, where it is white and shaped to form a suitable reflector.

(iii) *Reduced manufacturing cost.*

One of the main items of expense in manufacture is the cost of condensers. The ordinary instrument has one condenser for each calibration point, and each of these is hand-made in that it has to be taken to pieces and the foil and paper snipped away until it has the correct capacity to synchronize the lamps. This is laborious and time-consuming, and elimination of some of these condensers would effect a considerable reduction in expense. It was realized that, if the usual testing switch were arranged to introduce a suitable resistance in series with the hammer leads so that this resistance added to the resistance of the wood brought the total to a constant, one condenser would be sufficient. This arrangement is open to the three following objections:—

(*a*) The brightness of the test lamp glow would be reduced in every case to that obtained at the lowest moisture content.

(*b*) The sensitivity of the instrument would be reduced, because, to obtain the maximum discrepancy between the standard and test lamps, it is necessary to maintain a certain balance between the resistance in series and the capacity in parallel with the test lamp.

(*c*) Suitable high value resistors are not as yet readily procurable in Australia.

Bearing in mind that the expense lies not so much in using condensers as in having to adjust each one, it was decided to compromise and use as many condensers as necessary to overcome objections (*a*) and (*b*), but to use commercially available condensers and adjust them by incorporating resistors to trim the resistance of the hammer circuit so that the lamps synchronized at each point. Objection (*c*) limits the extent to which this arrangement can be adopted, and until arrangements are made to procure suitable resistors it is proposed to construct instruments according to the circuit shown in Fig. 1.

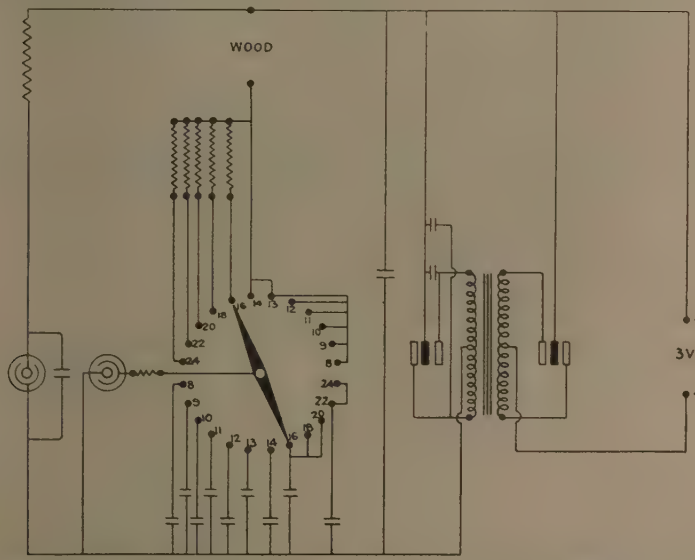

Fig. 1.—Circuit diagram of modified "Blinker" Electrical Moisture Meter.

After due consideration, the Division has decided to sponsor a twelve-point instrument calibrated for Douglas fir as standard. This will have setting points for the following percentage moisture contents:—8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 22, 24. For the time being individually adjusted condensers and no trimming resistors will be used for the points 8, 9, 10, 11, 12, 13, 14, per cent. moisture content. The points 16, 18, and 20 will all be connected to one commercial condenser and 22 and 24 to another, all these being trimmed by suitable resistors. The resistors are available very cheaply and can be very quickly and precisely adjusted to the correct values, by simply filing them down until the neon lamps are synchronized and then lacquering the exposed surface.

Such an instrument is illustrated in Plate 1, Fig. 2. The connexions are shown in Fig. 1.

(iv) *Reduction in weight and cost.*

Plate 1, Fig. 2 illustrates a re-designed instrument. The incorporation of the power supply unit and four torch cells in series parallel instead of the 180 volt battery, the use of a light weight switch, elimination of sub-panels, reduction in wood due to the smaller size of case, and elimination of several condensers have reduced the weight from 21 lb. to 10½ lb. The size has been reduced from 12¾ inches x 12 inches x 9½ inches to 9¾ inches x 13¼ inches x 4¾ inches.

(v) *Provision of a more convenient place for the hammer and leads.*

A compartment has been provided for the hammer and leads, and it is now easy to put these away quickly. The lid, which is not shown in the photograph, is approximately ¼ inch thick and is of a permanently fixed two-section type, hinged at the centre. Being much shallower, this instrument is more readily portable than the original one.

Acknowledgments.

The author wishes to acknowledge the great assistance he received from Mr. G. Frew, of Techtron Appliances, especially for translating the laboratory model of the vibrator unit into the commercial article.

Mechanical Tests on Small Clear Specimens of White Cypress Pine (*Callitris glauca*).

*By Ian Langlands, B.E.E., A.M.I.E.Aust.**

At the request of, and in co-operation with, the Queensland Forest Service, the Division of Forest Products has carried out a systematic series of mechanical and physical tests on eighteen trees of Queensland-grown white cypress pine. The detailed analysis of the results of these tests, which were carried out generally in accordance with B.S.I. and A.S.T.M. standard specifications† will be published in due course, but, in the meantime, it is considered advisable to give the species averages for the various tests.

The figures given are directly comparable with those for overseas species published previously.‡ It must be emphasized, however, that the figures apply to specimens completely free from defects, and they can, therefore, be used only in comparing the properties of pieces entirely free from defects or of equivalent strength grade.

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† British Standards Institution—Methods of Testing Small Clear Specimens of Timber. B.S.S. No. 373–1936.

American Society for Testing Materials—Standard Methods of Testing Small Clear Specimens of Timber. D143–27.

‡ Langlands, Ian—The Strength of Small Clear Specimens of Some Overseas Species. This *Journal* **11**: 302, 1938.

Mechanical Physical Properties of Small Clear Specimens of White Cypress Pine.

Property.	Moisture Condition.	—
Moisture content when green .. .. .. per cent.	..	54
Nominal Specific Gravity (weight oven-dry, volume at test)	Green	0·572
	12 per cent.	0·596
Weight per cubic foot .. .. .. (lb.)	Green	55
	12 per cent.	42
Shrinkage—		
Green to 12 per cent. moisture content—		
Radial .. .. .. (per cent.)	..	2·0
Tangential .. .. .. (per cent.)	..	1·8
Green to oven-dry—		
Radial .. .. .. (per cent.)	..	4·3
Tangential .. .. .. (per cent.)	..	4·3
Static Bending—		
Fibre stress at limit of proportionality (lb./sq. in.)	Green	6,020
	12 per cent.	8,610
Modulus of rupture .. .. (lb./sq. in.)	Green	10,400
	12 per cent.	11,400
Modulus of elasticity .. .. (lb./sq. in.)	Green	1,140,000
	12 per cent.	1,320,000
Work to limit of proportionality .. (in. lb./cu. in.)	Green	1·81
	12 per cent.	3·21
Work to maximum load .. .. (in. lb./cu. in.)	Green	11·0
	12 per cent.	6·7
Total Work .. .. .. (in. lb./cu. in.)	Green	18·0
	12 per cent.	6·8
Toughness—		
Load applied to radial face .. .. (in. lb.)	Green	112
	12 per cent.	57
Load applied to tangential face .. .. (in. lb.)	Green	119
	12 per cent.	67
Compression parallel to grain—		
Maximum crushing strength .. (lb./sq. in.)	Green	5,300
	12 per cent.	7,730
Compression perpendicular to grain (radial face)—		
Fibre stress at limit of proportionality (lb./sq. in.)	Green	1,370
	12 per cent.	2,550
Fibre stress at 1/10-in. deflection .. (lb./sq. in.)	Green	2,190
	12 per cent.	3,440
Hardness—		
Radial .. .. (lb.)	Green	1,020
	12 per cent.	1,360
Tangential .. .. (lb.)	Green	1,010
	12 per cent.	1,360
End .. .. (lb.)	Green	1,100
	12 per cent.	1,780
Shear (rebated specimen)—		
Radial .. .. .. (lb./sq. in.)	Green	1,400
	12 per cent.	1,510
Tangential .. .. .. (lb./sq. in.)	Green	1,440
	12 per cent.	1,620
Cleavage—		
Radial .. .. (lb./in.)	Green	200
	12 per cent.	130
Tangential .. .. (lb./in.)	Green	250
	12 per cent.	200

Observations on the Periodicity of Oestrus in Certain Australian Merino Ewes and a Half-bred Group.

Interim Report upon the Fertility of Sheep.

By R. B. Kelley, D.V.Sc., and H. E. B. Shaw, B.V.Sc.

Summary.

Continuous observations on three groups of Merino ewes and a group of Border Leicester x Merino ewes have shown a well-defined periodicity in the percentage number of ewes coming into oestrus.

In all groups there was a fall in the incidence of oestrus during the spring months followed by a rise in the summer months, the higher levels being maintained during late summer and autumn.

The results of the observations apply strictly to the locality of the McMaster Field Station. Their significance over the wider area of pastoral industry in Australia, and the environmental factors associated with the periodicity, are under investigation.

Introductory.

In 1935, studies in fertility of sheep were undertaken by the Division of Animal Health and Nutrition. They began with three groups of sheep classifiable by their previous breeding records as highly, lowly, and normally fertile, and among them the investigational procedure sought to establish normality for each reproductive process in order to determine departures from it.

The earliest studies (Kelley, 1937*) disclosed that, even among potentially fertile ewes, on occasion, some failed to come on heat with due regularity, so that, after "paddock matings," they were not in lamb. A typical example of this was the behaviour of a group of 33 stud ewes. Their owner had paddock-mated them on six consecutive occasions without offspring. Nevertheless, by extending the mating period, we caused them to produce 78 per cent. of lambs.

Accordingly, a series of observations was designed to investigate the periodicity of oestrus among normal Merino ewes, maintained under good, though ordinary, pastral conditions.

At first, 43 Merino ewes, all of the same strain and each of which had borne a lamb in the previous year, were depastured with sexually active vasectomized rams. During the period of observation (April, 1936, to May, 1937), these ewes did not appear and reappear on heat regularly. Therefore, throughout the following sixteen months (May, 1937, to September, 1938), a further test was carried out with a larger, and in some respects dissimilar, group of sheep. This group comprised twenty of the earlier ewes and two other lots of different Australian Merinos, together with one group of half-bred Border Leicester x Merino ewes.

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* Coun. Sci. Ind. Res. (Aust.) Bull. 112.

Observation of the first group was carried out upon portion of a property leased in the County of Cumberland (New South Wales). The second series was made upon the F. D. McMaster Field Station, recently established by the Council. This station is within approximately 5 miles of the leased property, and thus has highly comparable climatic conditions.

The Observations.

Having determined that colour spotting by vasectomized rams was a reliable test for oestrus in the ewe (Kelley, 1937), the groups under observation were depastured with suitably coloured rams of this kind. The rams were used at approximately 3 per cent. and changed every seventeen days. Further, to avoid overtaxing the working rams, ewes shown to have been on heat were withdrawn to be depastured with resting rams during their succeeding dioestrous periods.

On every seventeenth day, the rams were changed and a fresh colour used. The flocks were examined daily, and the tattoo identification numbers of coloured ewes were recorded. All the sheep were weighed at monthly intervals and cared for as described in the previous report upon these studies.

Fig. 1 shows the percentage of the ewes within the first group that could have been bred from in each month during the two periods of observation. The sheep were in part the same throughout.

The original number was 43, and the curve from April, 1936, until May, 1937, shows the number of ewes breeding during these and the intervening months as percentages of 43. In May, 1937, 23 of the original sheep were withdrawn after random selection, so that the curve from May, 1937, until September, 1938, shows percentages among the group of twenty remaining ewes.

Fig. 2 presents similar data within another ewe group which contained twenty Merino ewes from a different strain.

The curve in Fig. 3 was derived from data secured in still another group of twenty Merino ewes.

The " blood lines " of the ewes in each group were different from those in any other, and further, each group was secured from a different part of New South Wales.

The fourth ewe group (Fig. 4) comprised 21 first cross Border Leicester x Merino ewes.

The ewes in these groups were between four and six years of age, all in the three Merino groups had borne a lamb in a previous year, and during 1937-38 all four groups had received identical treatment. Nevertheless, as will be seen from the accompanying figures, and despite the fact that all the ewes were maintained in good condition throughout the period of observation, a high percentage within each group was not in a breeding state during the spring months. Further, the percentage capable of being bred during this period varied, and some of the Merino strains more closely approximated the reaction of the half-bred ewes than others.

Discussion.

It is possible, of course, that the results are applicable only to these sheep while in this locality. This is now being tested together with other probable associations of these observations. Broadly, however, the period during which these ewes ceased coming on heat (i.e., when they were not capable of being mated and bred) had a seasonal occurrence. Further, the observed breeding season was similar to that characteristic of British-bred ewes and by them ordinarily transmitted to their cross-bred progeny.

With regard to other associations, the data already accumulated have reference to those for number of ewes breeding and monthly body weights of the sheep and also with rainfall records. In neither case is an association apparent.

With regard to the monthly mean maximum temperatures and the hours of daylight during the period, possibly there is an association. The maximum temperature itself, however, is associated with the hours of daylight.

The equinoxes present an interesting feature with regard to the apparent association, in our evidence, of number of ewes breeding and hours of daylight. Notwithstanding the fact that each marks an equal duration of daylight hours, the spring and autumnal equinoxes are not associated with similar levels of breeding activity. The autumnal equinoxes are associated with full sexual activity and with its maintenance, while the spring equinoxes occur in the beginning of reduced activity. There is, however, the possibility that light at these seasons may be constituted differently with regard to its ultra-violet or other rays.

In view of the foregoing observations, and other data not yet presented, and despite the insufficiency of our present state of knowledge, we proffer the suggestion that, throughout Australia, great care should be taken by Merino sheep-breeders to synchronize arbitrarily selected times for paddock-mating with periods of sexual activity, because our data show that these, on occasion, are highly seasonal.

Acknowledgments.

The authors acknowledge with gratitude the assistance of the pastoralists who, while supplying them with sheep for these studies, desired to remain anonymous. Their thanks are also tendered to the New South Wales Government Astronomer for supplying data with regard to the hours of darkness and atmospheric temperatures in this area during the periods of observation.

The investigation was rendered possible by the financial support of the Australian Wool Board.

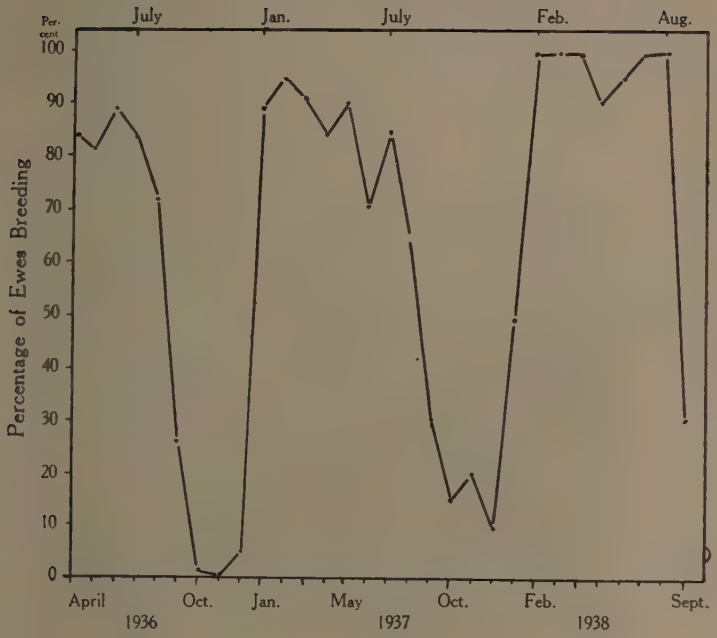
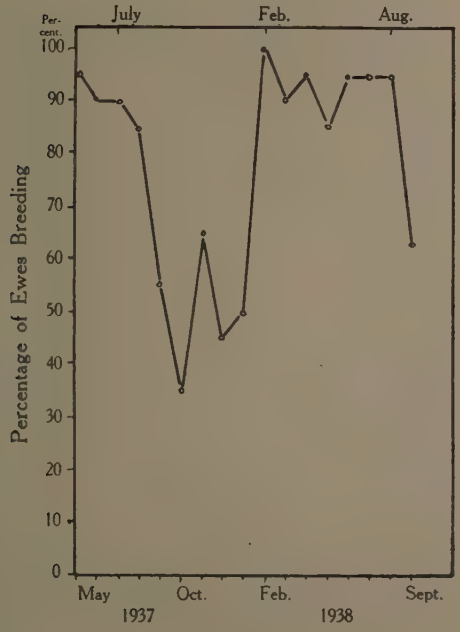

July
Jan.
July
Feb.
Aug.
Per-cent
100
90
80
70
60
50
40
30
20
10
0
Percentage of Ewes Breeding
April
Oct.
Jan.
May
Oct.
Feb.
Sept.
1936
1937
1938

FIG. 1.


July
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Per-cent.
100
90
80
70
60
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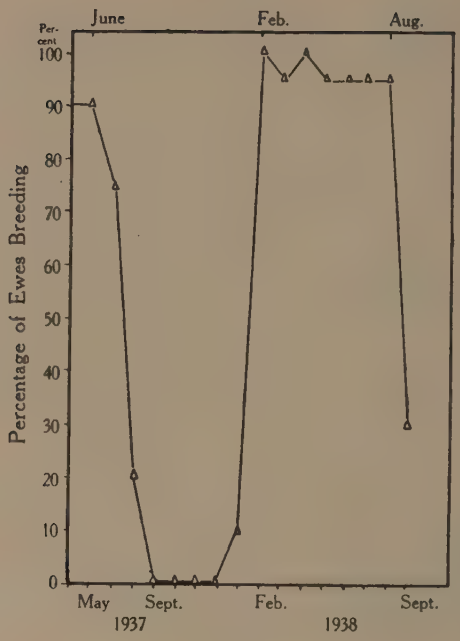
40
30
20
10
0
Percentage of Ewes Breeding
May
Oct.
Feb.
Sept.
1937
1938

FIG. 2.


June
Feb.
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Per-cent
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30
20
10
0
Percentage of Ewes Breeding
May
Sept.
Feb.
Sept.
1937
1938

FIG. 3.

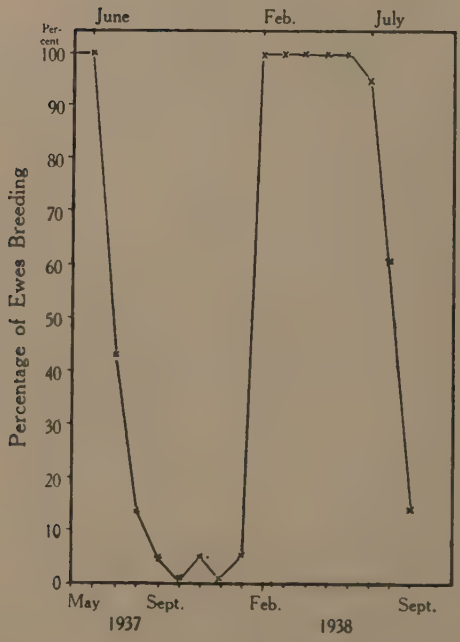
June
Feb.
July
Per-cent
100
90
80
70
60
50
40
30
20
10
0
Percentage of Ewes Breeding
May
Sept.
Feb.
Sept.
1937
1938

FIG. 4.

An Experiment to Detect the Possible Excretion of Nitrogen by Leguminous Plants.

*By R. E. Shapter, A.A.C.I.**

Summary.

An experiment has been carried out to determine whether soluble nitrogenous compounds accumulate in the medium external to the roots of growing leguminous plants, particularly at early stages of growth.

Lucerne was grown in a specially constructed apparatus which enabled the plants to be grown uninterruptedly, leachings of the culture medium being made at monthly intervals during the life of the plant. The root systems thus remained in their natural conditions undisturbed and unbroken.

The quantities of nitrogen which appeared in the culture medium and which in general tended to increase in the later leachings were so small, however, as to be of little significance.

The method employed has therefore not brought forward any positive evidence in favour of the excretion of nitrogen compounds from the roots of leguminous plants.

Amongst the investigations which have obtained considerable prominence in the field of agriculture in recent years, one receiving outstanding attention is the possibility of the excretion of nitrogenous bodies from the root systems of legumes. Varying results have been obtained, and the most consistently positive ones have been claimed by Virtanen (1 and 2) and his co-workers. Among other investigators, Thornton and Nicol (3), Wilson (4), Bond (5), &c., have not obtained conclusively positive results.† Certain co-operative work has also been carried out at the Waite Institute on the associated growth of pasture plants with negative results (6).

In most cases the investigations have been carried out in pot cultures, using various media such as quartz sand, kaolin, &c., sometimes in closed vessels in order to exclude all micro-organisms excepting pure cultures of nodule bacteria, while at other times open cultures have been used. It has also been the practice to harvest the plants and remove the root systems from the media and to analyse the residual sand.

The present note describes a method of open sand culture in which lucerne was grown for a period of nine months in a nitrogen-free medium, the plants being allowed to grow continuously to near maturity. The culture vessels were provided with an outlet tube at the base, which was closed by a stopcock which could be connected to a water pump. At the bottom of each vessel was a small cell of special design, covered by 100-mesh stainless steel gauze which was considerably finer than the finest particles of the sand used. The object of the cell was to prevent blockage of the outlet by roots, a larger area for outlet of liquid being given; fine gauze was used to prevent sand from entering the tube. By means of this apparatus the liquid could be drawn off from the vessel at intervals, the residual sand being then leached with weak culture solution. After leaching, the liquid was replaced with fresh

* An officer of the Council associated with Pasture Investigations, stationed at the Waite Institute, Adelaide.

† Thornton and Nicol have described results in which grasses have obtained benefit from association with lucerne, but state that they have made no attempt to trace out the course of the supposed transfer of nitrogen from legume to non-legume.

culture solution and the growth of the plants continued. The leachings could thus be analysed directly for nitrogen without any disturbance of the root system, fear of breakage, or detachment of nodules. Leachings were made monthly. The sand used was a pure white quartz (practically pure silica) such as is suitable for glassmaking. It was ground to pass a 1 mm. sieve, rejecting all that passed 40 mesh in order to avoid presence of troublesome fines. The coarser fraction was graded into (i) that which would pass a 1 mm. sieve and remain on a ½ mm. and (ii) that which remained on 40 mesh, after passing a ½ mm. sieve. A mixture of 75 per cent. of the coarser fraction with 25 per cent. of the finer fraction was used for cultural purposes. In order to remove adherent fine material, the graded sand was further washed with water in a hindered settling device. It was then dried and ignited at red heat, being poured several times from vessel to vessel in a thin stream through the air and while still red hot. This procedure was adopted to remove all nitrogenous bodies by destruction of any small quantities of organic matter present; at the same time it was the means of giving an initially sterile sand.

The vessels in which cultures were made held 1 kilogram of sand which was covered with a mulch of ½ inch to 1 inch of coarse quartz (¼ inch) which had been treated with hydrochloric acid to remove soluble impurities, dried, and ignited.

The plants were fed with a culture solution which was adequate in all constituents for plant growth except nitrogen, which was excluded. Pure chemicals of A.R. quality were used for preparation of the culture solution, and distilled water was used throughout the experiment. In order to avoid excessive concentrations of salts in such small vessels, the culture solution was added in modica, weekly at first and later daily, increasing the quantity of salts added as the plants grew older and larger and the rate of intake of minerals increased. As nearly as possible, the moisture content was maintained at a saturation value of 70 per cent.

After germination, the seedlings were inoculated with a pure culture of *Rhizobium meliloti* which had been proved to be very effective on lucerne. Leaching was carried out seven times at monthly intervals, commencing from when the plants were approximately two months old. At the time of the last leaching, some of the plants had produced such large root systems that the sand was being displaced from the culture vessels at the surface; these plants were harvested. The plants in two of the remaining vessels were now cut, and a remaining one was kept uncut as a control in order to observe the effect of cutting. Two more leachings were made at 10-day intervals after cutting.

Table 1 shows the average amounts of nitrogen (mgms. found per pot containing two plants), five pots being set up in all.

Table 1.

1st Leach.	2nd Leach.	3rd Leach.	4th Leach.	5th Leach.	6th Leach.	7th Leach.
0 25	0 43	0 49	0 89	0 52	0 95	2 35

Nine days after cutting two of the pots as stated above, the remaining three pots were again leached, and two of them were completely harvested. The remaining pot was kept as a control for the uncut pots.

Table 2 shows the nitrogen content from the two harvested pots (mgms.) at the eighth (final) leach.

TABLE 2.

—	8th Leach.
Pot 5	21.92
Pot 6	1·60

The remaining uncut control pot was subsequently leached twice more to correspond with the leachings made on the uncut pots; the amounts of nitrogen found are shown in Table 3.

TABLE 3.

8th Leach.	9th Leach.
4·10	5.91

Considering Tables 1, 2, and 3 together, there is a general tendency for the amounts of nitrogen found to increase in the later leachings.

Referring particularly to Table 2, one of the pots showed a very considerable increase in nitrogen content (the highest value observed for any pot). This indicates that small amounts of nitrogen may appear in the culture medium at later stages of growth (budding in this case), but it is not permissible to draw any conclusions as to its source.

The Effect of Cutting.

Table 4 shows the amounts of nitrogen (mgms. per pot) found in the leachings from the uncut control pot and the two pots containing cut plants.

TABLE 4.

—	7th Leach (Last Prior to Cutting).	1st Leach After Cutting.	2nd Leach (Final) After Cutting.
Pot 1 (uncut)	1.30	4.10	5.91
Pot 3 (cut)	2.37	15.04	8.97
Pot 4 (cut)	2.00	18.47	7.37

When compared with the control pot, there are substantial increases in nitrogen in the cut pots which fall off at the second and final leaching; the amounts found at the final leaching remain decidedly

greater than those found before cutting. It must be observed, however, that the increases in Pots 3 and 4 after cutting are both less than shown by Pot 5 (Table 2) which was uncut.

The total amounts of nitrogen taken up by the plants during growth, together with the total amounts found at all leachings, are given below:—

	mgms.
Total nitrogen in leaf and stem	1997
Total nitrogen in roots (including nodules)	1892
Total for whole plants	3889
Total nitrogen in leachings	127*

The total amounts of nitrogen found in the leachings are therefore insignificant when compared with the amounts contained in the plants themselves.

The results may be interpreted in a variety of ways. The quantities of nitrogen found in the leachings are very small compared with the total nitrogen of the plants, but this does not necessarily imply the absence of excretion from any part of the root system. Any such possible excretion might be taken up by some other portion of the root system, so that the amounts found may represent a balance of output and intake.

There is a possibility that free living organisms may have been able to fix small amounts of nitrogen, the source of energy for such organisms being derived from the root system.

The gradual increase over the season in the quantity of nitrogen found in the leachings may be associated with the senescence of the root system. This may explain particularly the exceptional value recorded for Pot 5 in Table 2.

It is evident that the experiment in itself does not disclose any appreciable excretion from the root system of the lucerne plant, and that if such excretion of nitrogen compounds took place the products were immediately re-sorbed.

The somewhat larger quantities of nitrogen appearing in the leachings immediately after cutting may be of some significance.

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* Inclusive of 20 mgms. found in root washings (part of which no doubt derived from fractured portions of the roots), as well as 50 mgms. found in the leachings made subsequent to cutting.

Further Free Water Investigations in Renmark.

*By A. L. Tisdall, M. Agr. Sc.**

1. Introduction.

In a previous paper†, mention was made of lines of test wells in the Renmark and Chaffey Irrigation Areas. These lines were established for the purpose of examining the existing free water conditions in the areas; also to give information, if possible, on the influence of the Murray River or Ral Ral Creek on the heights of water tables in various parts of the settlements, and the extent of possible movements of underground water.

Accordingly, the lines commenced at the river or creek, and extended more or less at right angles into the settlements for distances of up to 3 miles.

An interim report was presented in the above paper. The investigations have now been completed, and the observations examined in the light of another two and a half years' data.

2. Location of Sites.

Four lines of test wells were used, and the details of their positions are as follows:—

(i) Section A (Blocks A and B, Renmark).—This line commenced on the river bank, continued along the south side of Twenty-seventh Street, across Renmark Avenue, and ended just south of Rialto Street. There were nine wells in a distance of just under 3 miles.

(ii) Section B (Block E, Renmark) commenced at Ral Ral Creek and continued along Barnon Street to Ral Ral Avenue. There were eight wells in the 2 miles.

(iii) Section C (Block E, Renmark) commenced at Ral Ral Creek and continued along Nelbuck Street to Ral Ral Avenue‡. There were five wells in just over 2 miles.

(iv) Section N (Chaffey Irrigation Area).—Again the line commenced at Ral Ral Creek, and continued west, on a line between allotments 94 and 59, ending on the boundary of allotments 58 and 59. There were seven wells in approximately ¾ mile.

3. Procedure.

The free water levels in all wells were recorded fortnightly. At the same time, the fluctuations in level of the creek and river were taken. The records for each well were then graphed separately against time, and examined in relation to incidence of irrigation.

From a survey, reduced levels of the well sites were obtained. Sections (as in Fig. 1) were then drawn to show the basal winter level, and the average height to which the free water rose in summer in relation to surface contour, and the level of the river or creek. At one period, namely February, 1936, samples of water from all test wells were analysed for salt content.

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* An officer of the Council attached to the Commonwealth Research Station, Merbein.

† A. L. Tisdall.—Free Water Investigations in the South Australian Areas of the Murray Valley. This *Journal* 9: 301, 1936.

‡ The Department of Lands had two wells along Nelbuck Street, and these were included.

4. Discussion.

(*a*) Considering the water table in relation to irrigation, the fluctuations generally were similar to those already described for other settlements.

For Renmark, it may be stated briefly that—

(i) On all irrigated soils examined, free subsoil water was present at all times within 11 feet, and in many cases within 7 feet, of the surface. The levels rose considerably with irrigation. It is also interesting to note that the free water levels on the irrigated portions of Sections A and C were almost as high in January, 1938, as they were following heavy January rains in 1936.

(ii) On unirrigated soils, the water table was in general lower than on the adjacent irrigated portions. The fluctuations were slight, the level during the irrigation season being generally 6 inches to 1 foot higher than the winter level.

(*b*) With regard to the influence of the creek or river level on the water table, the effect did not appear to be far-reaching. The period of the investigation included one interval of high river, when the level in the lockpool rose to approximately 4 feet above normal, and the level at Section A rose to approximately 10 feet above normal, both maxima being recorded at the end of October, 1936.

The only wells which reflected this rise were A1, C1, and to a lesser extent N1. All these were within 2 chains of the river or creek. The next wells on each line were unaffected, viz.—

Well number A2, 24 chains from the Murray River.
Well number C2, 26 chains from the Ral Ral Creek.
Well number N2, 9 chains from the Ral Ral Creek.

In Section B, well number 2 was subject to flooding from the creek, but the levels in numbers 3 and 4, which are on irrigated land, did not appear to be influenced by creek level.

In Section N, well number 3 (unirrigated) maintained a higher level in 1937 and 1938 than it had previously, but, as the levels in the wells on each side remained low, the effect was probably due to the immediate surroundings rather than to the influence of the creek.

The water table can be continuously followed right to the creek or river on all lines, but is higher on the irrigated portion than the unirrigated land nearer the river, even though the latter be on a lower contour.

The salt content of samples taken from the test-wells is in general higher than the amount allowed in irrigation water, and the figure appears to be higher on the unirrigated portion.

5. Conclusion.

In general, it may be stated that the most important factor influencing the rise of the water table in the irrigated lands examined was the incidence of irrigation. Further, irrigation appears to exert a slight influence on the water table in the unirrigated country.

Fluctuations in the level of the Ral Ral Creek or the Murray River did not appear to have any influence, beyond a few chains, on even the unirrigated flats, which are between the irrigated lands and the river or creek.

6. Acknowledgments.

Thanks are due to Mr. A. C. Ingerson, of Berri, who assisted in the work, and to officers of the Department of Lands for their co-operation in arranging for regular observations to be taken.

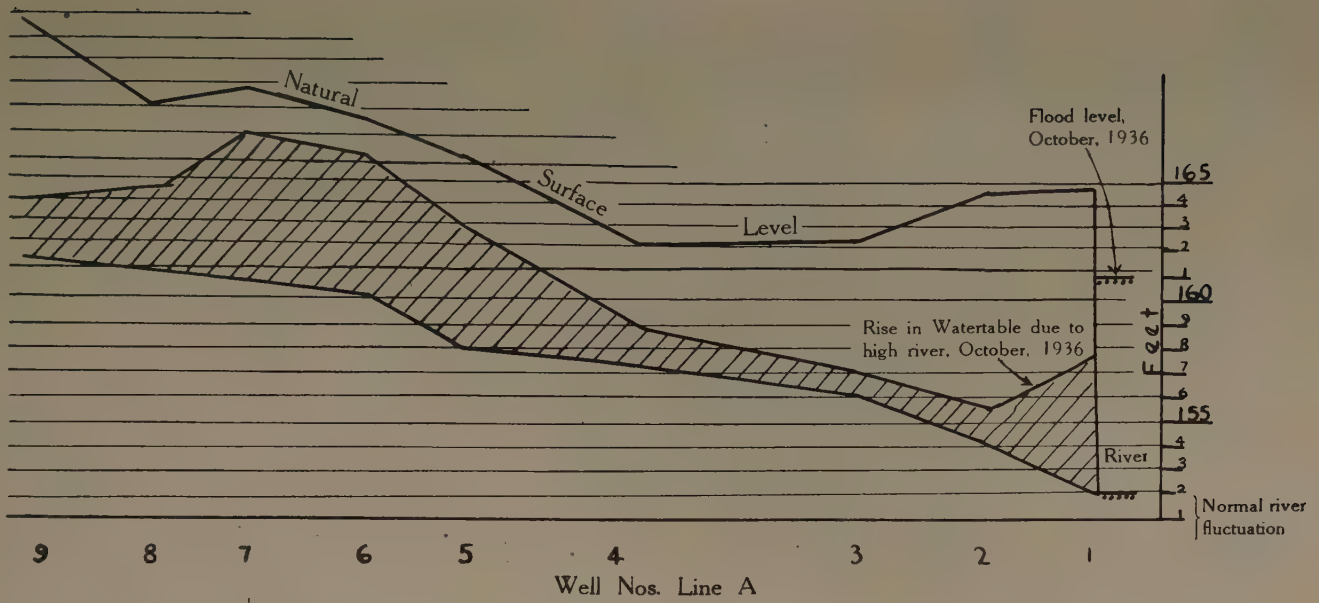


FIG. 1.—Section A, blocks A and B, Renmark. Well numbers 5, 6, 7 and 8 on irrigated land Free Water Fluctuations December, 1935—September, 1938 shown thus ▨. *Scales:* Vert. 8 ft. to 1 in.; Horiz. 40 chs. to 1 in.

The Preservation of Timber Against the Attacks of the Powder Post Borer (*Lyctus brunneus* Stephens) by Impregnation with Boric Acid.

*By J. E. Cummins, M.Sc., A.A.C.I.**

Summary.

The results of laboratory tests have shown that boric acid, borax, or mixtures of boric acid and borax in low concentrations in wood prevent infestation by Lyctus.

Laboratory and commercial tests have shown that green veneer can be easily and satisfactorily treated at a relatively low cost, which is economically sound.

Details are given and recommendations made for the commercial treatment of various Australian timbers. A provisional patent specification for the treatment outlined has been lodged and accepted.

1. Introduction.

In a previous publication (1) details were given of the results of laboratory experiments to determine the value of various chemicals, when impregnated into susceptible sapwood to prevent attack by Lyctus. These experiments indicated that sodium fluosilicate was the most toxic chemical tested, and that when it was used in concentrations as low as 1/40 lb. of dry salt per cubic foot of wood, equivalent to 0.06 per cent. of chemical, based on the air-dry weight of the wood, complete immunity was conferred on the susceptible sapwood. Sodium fluosilicate appeared to be a desirable chemical for commercial use. Laboratory and semi-commercial experiments were planned, and certain of this work completed, when a detailed study on fluorine intoxication by Roholm (2) was published. This publication indicated the danger which might accrue from the use of fluosilicates in the woodworking industries. Roholm, as a result of his extensive investigations, considers that osteo-sclerosis, a disease of the bones, can occur in man by the daily ingestion of 0.20 to 0.35 milligrams of fluorine per kilogram of body weight. The changes in bony tissue that result do not appear until several years of regular fluorine ingestion, the fluorine being a cumulative poison. He recommends that females and young people should be prohibited from employment on work with fluorine compounds which may occur as a dust or vapour. Where other workers are exposed to the effects of fluorine, they should be adequately protected, and fluorine intoxication should be recognized as an occupational disease entitling the sufferer to compensation.

It is obvious that the use of fluorine compounds for the treatment of veneers is attended with considerable hazard from dust, this arising principally from the sanding machines and trim saws. Consultations with the Public Health Department of Victoria† indicated that it was extremely unwise to recommend the use of sodium fluosilicate for the treatment of veneers, and further experimental work was therefore stopped and the timber trade notified accordingly.

Consideration was therefore given to the various chemicals previously used (1), and a further series of tests, using boric acid, mixtures of boric acid and borax, and zinc chloride, was inaugurated.

* Officer-in-Charge, Preservation Section, Division of Forest Products.

† D. O. Shiels, D.Sc. (Melb.), Ph.D. (London), F.I.C., F.A.C.I., M.B., B.S. (Melb.), Medical Officer of Industrial Hygiene.

This paper gives the results of these further laboratory tests, the results of semi-commercial treatments, and also recommendations for the treatment of veneers of sapwood susceptible to Lyctus.

2. Review of Literature.

Since the publication of the previous paper a short resumé of work carried out at the Forest Products Research Laboratory, Princes Risborough, has appeared (3). Pieces of oak sapwood were immersed, for periods up to five minutes, in 5 per cent. aqueous solutions of zinc chloride, sodium fluosilicate, borax, and potassium chromate, and a 3 per cent. solution of sodium fluoride. The samples were submitted to Lyctus attack approximately two months after treatment, but none of the salts prevented infestation at the concentrations mentioned, apparently owing to ineffective penetration. The beetles oviposited below the treated surface, which only contained a concentration of from 0.004 to 0.008 g. of salt per sq. cm. of wood surface. Although no details are given, it appears, that dry sapwood was used, and it is suggested that better penetration and higher absorptions would be obtained if green wood and hot solutions had been employed.

No further publications have been noted, and reference to the previous paper should be made for a review of the pertinent literature.

3. Laboratory Beetle Tests.

The method of testing has been previously described (1). In this series, the wood used was *Sloanea woollsii* (yellow carabeen), and each test specimen was separately tested for the presence of starch, only specimens containing a medium amount (grading 2–) or more being used, except in the case of two controls. As before, each treated specimen and each untreated control was placed in a separate petri dish, the bottom of which was coated with paper, and submitted to Lyctus attack by introducing ten pairs (male and female) of freshly emerged beetles into each dish.

The results of this test are shown in Tables 1 and 2, together with the results of previous tests with borax for comparison. A study of the tables shows that boric acid alone, or as a mixture with borax, has a relatively high toxicity to Lyctus larvae. The apparent lethal concentrations, as a percentage of the air-dry wood, are about 0.12 per cent. for boric acid, 0.2 per cent. for a mixture of two parts of boric acid plus one part of borax, 0.11 per cent. for a mixture of equal parts of boric acid and borax, and 0.2 per cent. for borax alone. When the boric acid and the mixtures are converted to equivalent percentages of boron, the lethal concentration appears to be about 0.02 per cent. of boron, there being a relatively small variation between the mixtures used (see Table 2). This indicates that the effective toxicity is due to the boron content. At concentrations of 0.01 per cent. or less, the degree of attack on the specimens markedly increases, and in general they were destroyed by larval activity.

Zinc chloride appears to differ markedly in its action on Lyctus larvae. Larval activity occurs at relatively high concentrations of about 0.7 per cent. zinc chloride, although the extent of the damage is very slight, the larvae dying in an early stage of development. Even at a concentration of 0.14 per cent., the lowest limit tested, the larval damage was only slight, although in one specimen containing 0.52 per cent. zinc chloride, one mature, but small, beetle emerged.

TABLE 1.—RESULTS OF TESTS OF PRESERVATIVES AGAINST LYCTUS BEETLES.

Name of Preservative.	Absorption of Total Preservative (lb./cu. ft.).	Percentage of Total Preservative (on Air-dry Weight of Wood).	Starch Content of Specimens.	Extent of Damage to Specimens after about One Year.
Boric acid (H_3BO_3)	0·24	0·53	2 +	Nil
	0·19	0·42	2 +	Nil
	0·11	0·26	2	Nil
	0·11	0·26	2 +	Nil
	0·06	0·14	2	Nil
	0·05	0·11	2	Slight attack
	0·03	0·06	2 −	Destroyed
	0·03	0·06	2	Destroyed
	0·01	0·03	2	Destroyed
	0·01	0·03	2 −	Destroyed
Boric acid (two parts) Borax (one part), (by weight)	0·23	0·61	2 +	Nil
	0·24	0·50	2	Nil
	0·12	0·29	2	Nil
	0·12	0·28	2	Nil
	0·07	0·18	2 −	Very slight attack
	0·07	0·16	2	Slight attack
	0·03	0·08	2 −	Extensive attack
	0·03	0·07	2	Extensive attack
	0·02	0·05	2	Extensive attack
	0·02	0·04	3	Moderate attack
Boric acid (one part) Borax (one part), (by weight)	0·22	0·51	2	Nil
	0·23	0·50	2	Nil
	0·11	0·22	2	Nil
	0·11	0·22	2	Nil
	0·05	0·12	2	Nil
	0·05	0·10	2	Moderate attack
	0·03	0·07	2 −	Moderate attack
	0·03	0·06	2 +	Destroyed
	0·02	0·03	2	Destroyed
	0·01	0·02	2 +	Destroyed
Borax* ($Na_2B_4O_7.10H_2O$)	0·3	1·21	1 +	Nil
	0·3	1·01	2	Nil
	0·2	0·57	2	Nil
	0·1	0·26	2	Nil
	0·04	0·13	2 +	Very slight attack
Zinc chloride ($ZnCl_2$)	0·42	1·04	2 −	Nil
	0·33	0·72	2 +	Very slight attack
	0·19	0·52	2	Slight attack
	0·13	0·35	2	Slight attack
	0·09	0·23	1 +	Slight attack
	0·06	0·14	2 +	Slight attack
Controls A (untreated)	..	..	2 −	Destroyed
	..	..	2	Destroyed
	..	..	1 +	Destroyed
	..	..	1 +	Destroyed
Controls B (treated with water according to schedule used for treated specimens)	..	..	2 +	Destroyed
	..	..	2	Destroyed

* Results from previous experiments.

Table 2.—Summary of Results of Lyctus Beetle Tests.

Item.	Boric Acid.		Boric Acid (two parts), Borax (one part).		Boric Acid (one part), Borax (one part).		Borax.		Zinc Chloride.
	Alone.	Equivalent Boron.	Mixture.	Equivalent Boron.	Mixture.	Equivalent Boron.	Alone.	Equivalent Boron.	
Lowest concentration at which no larval development occurred ..	0·14	0·024	0·28	0·037	0·12	0·018	0·26	0·028	1·04
Highest concentration at which larval attack occurred ..	0·11	0·019	0·18	0·023	0·10	0·014	0·13	0·014	0·72
Highest concentration at which specimens destroyed by larvae	0·06	0·010	Less than 0·04	Less than 0·007	0·06	0·009	..	..	Less than 0·14

All figures as percentages based on air dry wood.

The presence of larval galleries, of visible extent, particularly in veneers and furniture timbers, is considered to be undesirable, and although larval development is almost completely arrested before the pupal stage, the use of zinc chloride is not advocated. Boric acid or borax alone, or in mixtures, definitely prevents Lyctus development in low concentrations. The use of these is dependent upon other factors which are discussed in the next section.

4. Laboratory Tests on the Treatment of Green Veneer.

(a) Discussion.

The beetle tests reported above indicated that there was little, if any, practical difference between the toxicity of boric acid, borax, or mixtures of these. It is known that alkaline solutions, particularly with certain timbers, cause discolouration. Also, in previous experiments with sodium fluosilicate solutions, it was found that, after repeated treatment with a stock solution, considerable quantities of extractives were removed from the green wood, the colour of the treating solution markedly increasing in intensity with increase in the number of treatments. Preliminary tests were therefore made to determine this effect. Solutions of boric acid alone were found to be markedly superior. The pH of the fresh 2 per cent. solution was found to increase slightly, from a value of pH 5 to from pH 5.7 to 5.8, and a 1 per cent. solution from pH 5.7 to pH 6.3. A mixture of four parts of boric acid to one part of borax gave an initial pH of 7.3, which was reduced after treatment to pH 7.1. Although only slightly alkaline, there was a marked reaction with the extractives dissolved, and it was decided to adopt the use of boric acid alone. Reference to literature and laboratory tests also showed that boric

acid solutions of the order of 1 to 2 per cent. had very little corrosive effect on copper.

(*b*) *Methods of treatment.*

In the manufacture of veneer and plywood, there are four stages in the conversion of the timber at which treatment may be applied. These four stages are as follows:—

(i) Treatment of the green log.
(ii) Treatment of the green veneer.
(iii) Treatment of the dry veneer.
(iv) Treatment of the glue line.

(i) *Treatment of the green log.*—Under Australian conditions, two methods of log or flitch treatment, preliminary to peeling or slicing are used, namely, steaming and boiling, i.e., heating in water. The former does not allow of its use for impregnation, but it appeared that there was a possibility of using the boiling process, by inclusion of chemical in the water in the vats. Any penetration resulting in the green logs would be by diffusion.

The average depth of sapwood on many of the hardwood (pored) timbers used for veneers exceeds 2 inches and is sometimes considerably greater, averaging 4 inches to 6 inches. Some preliminary tests with green logs of red tulip oak and heating treatment extending to three and a half days' heating and cooling, during which the temperature ranged from 150°F. to 170°F. for 36 hours plus an extra one and a half days' cooling to 90°F., and using a 1 per cent. solution of sodium fluosilicate, showed a negligible amount of chemical below a depth of 2 inches and insufficient to give immunity from Lyctus attack. (See Table 3.) Further tests with boric acid were not deemed necessary.

TABLE 3.—ABSORPTIONS OF SODIUM FLUOSILICATE IN GREEN RED TULIP OAK LOG, TREATED BY HEATING IN 1 PER CENT. SOLUTION.

Sample Position.	Percentage of Sodium Fluosilicate (Calculated on Air-dry Weight).
2 inches to 3 inches below bark	0·06
3 inches to 4 inches below bark	0·03

(ii) *Treatment of the green veneer.*—Sorting of susceptible sapwood can be easily, cheaply, and quickly accomplished at the lathe or slicer, and detailed work was therefore undertaken, as reported later.

(iii) *Treatment of the dry veneer.*—Treatment of dry veneer, particularly of sapwood, can be easily accomplished using the ordinary hot and cold bath process, and, by adjusting the strengths of the treating solutions and times of treatment, adequate absorption can be obtained, together with complete or almost complete penetration. Such a treatment, however, necessitates a double drying of the veneers and considerable extra handling, so that economically it would be unsound and less satisfactory than the treatment of green veneer, if this could be successfully accomplished.

(iv) *Treatment of the glue line.*—The inclusion of toxic chemicals in the glue has been suggested at various times, but no detailed work has been reported. A series of tests was made using a range of chemical materials, but the results were unsatisfactory. A paper on this work is now being prepared for publication.

In view of the above discussion and the results of the tests undertaken, detailed work was confined to the green veneers.

(*c*) *Treatment of green veneers.*

Supplies of green rotary cut sapwood of three timbers, namely, white lauan (*Shorea* sp.), erima (*Octomeles sumatrana*), and red tulip oak (*Tarrietia argyrodendron* var. *peralata*) were obtained. These species were chosen on account of their availability and variation in density. Erima is an open textured timber of low density, 22 lb. per cubic foot air-dry, white lauan an open textured timber of an average air-dry density of 32.5 lb. per cubic foot, and red tulip oak a finer textured timber with considerable longitudinal parenchyma, which is starch containing, and a density, air-dry, of 48 lb. per cubic foot. Matched pieces about 6 inches x 3 inches were cut of each species, and two pieces treated green with various concentrations of boric acid, for varying times, and at varying temperatures. Treatment consisted of completely immersing the test pieces of veneer in the requisite solution and leaving them therein for the time period required. At the conclusion of this time, they were quickly removed from the solution, excess or adhering solution wiped off, and the pieces air-dried to equilibrium moisture content. After drying, the surfaces of the pieces were lightly sanded to remove any chemical which may have been deposited on the surface because of evaporation of adhering solution, and the whole of each set of samples ground up for analysis. A weighed portion of the ground up sample was ashed at a low temperature in a platinum crucible with lime eschka mixture, the ash extracted, and the boric acid subsequently determined by titration with sodium hydroxide in the presence of glycerol. The results of the tests made are given in Tables 4, 5, and 6. Fig. 1 shows the results from Table 5 in graphical form, and is representative of the general trend of the results from the other two species.

A study of Tables 4, 5, and 6 show that adequate absorption of boric acid can be obtained using a relatively short treatment time. The absorptions obtained are dependent upon the three variable treating factors. Increase in temperature markedly increases the absorption and the diffusion rate of the chemical, the results emphasizing the value of a hot treatment. The rate of diffusion and the degree of absorption with cold solutions is relatively slow and shows an early diminution in rate with time, so that effective treatment to give complete, or almost complete, penetration at low temperatures would require a very long time factor. With 1/16-in. veneer and a 1 per cent. solution at 200°-212°F. the total absorption reaches close to a maximum of fifteen minutes. Although the quantity of preservative absorbed in the various thicknesses of veneer treated for periods less than fifteen minutes is sufficient in amount to render the veneer resistant to Lyctus, the distribution of the preservative is often unsatisfactory, qualitative tests, using turmeric paper and also treating similar veneer under the same conditions with zinc chloride, and testing for the presence of zinc, showing that penetration was often incomplete, and that the centre remained free from preservative. This factor was more definitely indicated in the $\frac{1}{8}$-in. veneer for which a minimum time

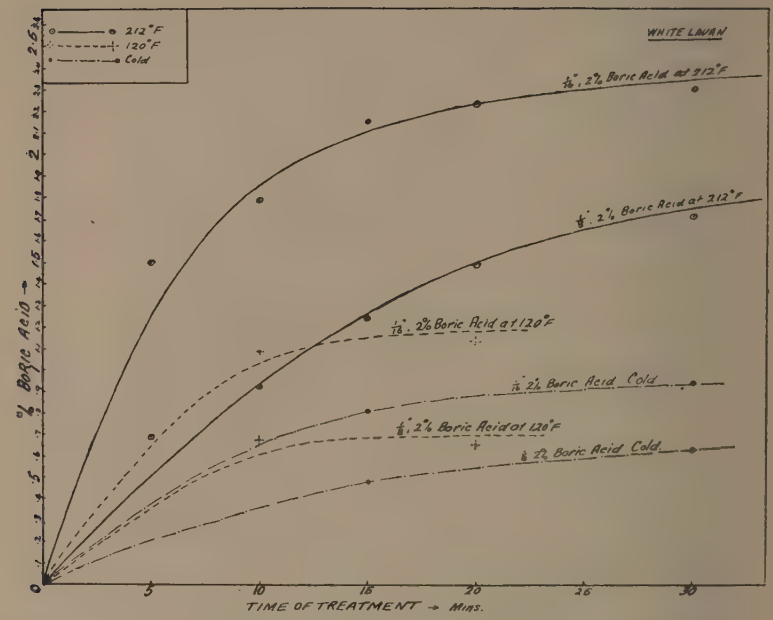


FIG. 1—Graphs showing relation between boric acid absorbed and time of treatment, temperature and thickness of treated wood.

TABLE 4.—PERCENTAGE OF BORIC ACID IN MATCHED SAMPLES OF GREEN ERIMA VENEER TREATED WITH A 1 PER CENT. AND 2 PER CENT. BORIC ACID SOLUTION.

Time of Treatment (in Minutes).	Conc. of Solution (per cent.).	1/30-in. Veneer.			1/10-in. Veneer.		
		Temperature of Treatment.			Temperature of Treatment.		
		60°–70° F.	120° F.	200°–212° F.	60°–70° F.	120° F.	200°–212° F.
10 ..	1	..	1·03	1·37	..	0·76	1·06
	2	..	1·97	2·87	..	1·28	2·61
15 ..	1	..	..	1·47	..	..	1·52
	2	1·51	..	2·84	1·11	..	2·40
20 ..	1	..	1·23	1·73	..	0·87	1·69
	2	..	2·34	2·93	..	1·51	2·48
30 ..	1	..	..	..	..	..	..
	2	1·51	..	..	1·45	..	..

Table 5.—Percentage of Boric Acid in Matched Samples of Green White Lauan Veneer Treated with a 2 per cent. Boric Acid Solution.

Time of Treatment (in Minutes).	1/16-in. Veneer.			1/8-in. Veneer.		
	Temperature of Treatment.			Temperature of Treatment.		
	60°–70° F.	120° F.	200°–212° F.	60°–70° F.	120° F.	200°–212° F.
5	..	..	1·50	..	..	0·69
10	..	1·09	1·79	..	0·67	0·92
15	0·81	..	2·15	0·48	..	1·24
20	..	1·13	2·23	..	0·65	1·49
30	0·94	..	2·30	0·63	..	1·71

Table 6.—Percentage of Boric Acid in Matched Samples of Green Red Tulip Oak Veneer Treated with a 1 per cent. and 2 per cent. Boric Acid Solution.

Time of Treatment (in Minutes).	Conc. of Solution (per cent.).	1/16-in. Veneer.			1/8-in. Veneer.		
		Temperature of Treatment.			Temperature of Treatment.		
		60°–70° F.	120° F.	200°–212° F.	60°–70° F.	120° F.	200°–212° F.
10 ..	1	..	0·36	0·68	..	0·25	0·41
	2	..	0·83	1·26	..	0·46	0·76
15 ..	1	..	..	0·85	..	..	0·44
	2	0·58	..	1·35	0·36	..	0·85
20 ..	1	..	0·56	0·87	..	0·29	0·55
	2	..	0·98	1·40	..	0·59	0·93
30 ..	1	..	..	..	..	..	..
	2	0·67	..	..	0·41	..	..

period of twenty minutes at 200°-212°F. is considered necessary to provide a sufficient (not always complete) depth of penetration. With increase in thickness beyond 1/8-in., the time period for complete or effective penetration materially increases, and it is considered that, in thicknesses greater than 3/16-in., the process becomes uneconomical for the treatment of sapwood veneer owing to the time of treatment required. It is preferable to treat susceptible sapwood in thin veneers and to cut thicker veneers, if required, from the non-susceptible true-wood. Treatment with cold solutions or solutions at 120°F. for periods up to 30 minutes, using both 1/16th and 1/8th veneers, failed to give adequate penetration.

The concentration of the treating solution markedly affected absorption but did not materially affect the degree or rate of penetration.

It will be noted from Tables 4 and 6 that doubling the concentration of the treating solution approximately doubled the gross absorption obtained, using similar veneers and the same treatment schedule.

The maximum absorptions obtained with ⅛-in. veneer are materially less than with 1/16-in. veneer, the difference being due to the distribution of the preservative.

Laboratory tests having shown the possibility of effectively treating green veneer, commercial tests were inaugurated in a plywood mill at Brisbane, Queensland.

5. Field Tests on the Treatment of Green Veneer with Boric Acid.

Field tests were made at the plywood mill of Brisbane Sawmills Limited, Windsor, Queensland, where a commercial plant, somewhat similar to that described later, was used.

The strength of the treating solution was fixed at 1.25 per cent. boric acid, it being considered desirable to ensure that any veneer treated should be effectively penetrated with a sufficient quantity of preservative. The factor of safety is fairly high and varies somewhat according to the thickness of the veneer and the species of timber, in general being lower in denser material. During the commercial treatments, the strength of the solution varied somewhat, the range being from 1.21 per cent. to 1.36 per cent. boric acid, until sufficient information was available to determine a routine for maintaining the solutions at a fairly constant strength. All treatments were made at temperatures of from about 200° to 205°F., which range of temperature was easily maintained.

In carrying out the commercial treatments, supplies of green sapwood veneer were obtained from the lathe. All the veneer contained starch, although this varied in amount. Sometimes, the veneer treated had only been cut a few minutes, while in other cases it had been block-stacked for several days. Except for the top two or three sheets, the block-stacked veneer had not dried materially and was perfectly satisfactory for treatment. The erima veneer was obtained from logs which had been stored in the open without bark for some months and the outer sapwood had dried considerably. This drying effect was particularly noticeable in some 7/32-in. veneer which was submitted to treatment and which was cut from the outer portion of the log. Owing to lack of logs it was not possible to repeat the tests with green erima.

In making the commercial treatments, a minimum time schedule was generally fixed, as a result of the laboratory experiments, at ten minutes for 1/16-in. veneer and twenty minutes for 1/8-in. veneer. If this treatment gave satisfactory results, further tests were not made. It is possible that in cases, times of treatment recommended may be slightly decreased, but no great practical advantage would accrue, and it was considered desirable to keep the schedules as simple as possible for commercial practice. For analyses, several sheets of veneer, 6 feet x 3 feet, were taken from each treatment and used for testing; at least three pieces about 12 inches square were removed from each sheet at random places, and then these small pieces further sampled and a composite sample for analysis thus prepared from the various sheets in the treatment. For each sample sheet, determinations were also made of the air-dry density. All results were calculated as a percentage of boric acid on the air-dry weight of the wood. In the case of 3/16-in. and 7/32-in. veneer, analyses were made of the outer 1/16 inches and the inner portion. The presence of boric acid at the centre of

the veneer was tested with turmeric paper. The veneer was carefully split through the centre, moistened on the inner surface with a few drops of dilute hydrochloric acid, and turmeric paper applied to the moistened surface. When tested, positive indications of the presence of boric acid were obtained. The results of the analyses of commercially treated veneer are shown in Tables 7, 8, and 9.

A study of Table 7 shows that adequate absorption of boric acid occurs with treating schedules as low as eight minutes for 1/16-in. veneer. As previously mentioned, however, the penetration was not always satisfactory. It will be noted that, although the percentage of

TABLE 7.—ABSORPTIONS OF BORIC ACID IN TREATED VENEERS.
Veneer thicknesses 1/16-in. and 1/19-in.

Species.	Sample Number.	Average Air-dry Density (lb. per cu. ft.).	Time of Treatment (in Minutes).	Temperature Treatment (°F.).	Percentage of Boric Acid (on Air-dry Wood).	Absorption of Boric Acid (lb. per cu. ft.).
Erima, $\frac{1}{16}$-in. ..	47	20·3	8	201	1·10	0·22
	45	20·9	10	200	1·53	0·32
Pepperwood, $\frac{1}{16}$-in. ..	15	33·4	8	198	0·92	0·31
	13	25·6	10	201	1·07	0·27
	14	28·8	10	201	0·96	0·28
	17	32·7	10	203	1·11	0·36
Queensland walnut, $\frac{1}{16}$-in.	46	41·7	8	200	0·64	0·27
	44	44·0	10	201	0·69	0·30
Silver ash, $\frac{1}{16}$-in. ..	16	35·2	8	198	0·83	0·29
	18	36·2	10	202	0·94	0·34
White lauan, $\frac{1}{16}$-in. ..	12	33·0	10	200	0·80	0·26
Tarzali silkwood $^1/_{19}$-in.	27	36·3	5	201	1·02	0·37
	28	36·7	8	204	1·01	0·37
	25	35·9	10	203	0·93	0·33
Yellow walnut, $^1/_{19}$-in.	26	41·6	5	201	0·89	0·37
	29	44·5	8	204	0·73	0·33
	24	43·7	10	203	0·79	0·34

boric acid found varies considerably in the different species, the absorption of boric acid per cubic foot of wood is fairly constant when similar treatments are compared. Woods of high density naturally give a lower percentage for an equivalent absorption per cubic foot. Thus, erima of 20.9 lb. density gives a percentage of 1.53 and an absorption of 0.32 lb. per cubic foot, while Queensland walnut of density 44.0 gives a percentage of 0.69 but practically an equal absorption to the erima of 0.30 lb. per cubic foot. Similar results obtain with the other species. The average absorption of 1/16-in. veneer, treated for ten minutes is 0.30 lb. In 1/19-in. veneer this increases somewhat.

TABLE 8.—ABSORPTIONS OF BORIC ACID IN TREATED VENEERS.

Veneer thickness 1/8-in.

Species.	Sample Number.	Average Air-dry Density (lb. per cu. ft.).	Time of Treatment (in Minutes).	Temperature Treatment (°F.).	Percentage of Boric Acid (on Air-dry Wood).	Absorption of Boric Acid (lb. per cu. ft.).
Erima	42	21·7	15	204	1·21	0·26
	39	21·6	20	195	1·18	0·25
Pencil cedar.. ..	23	36·8	15	204	0·52	0·19
	22	35·9	20	205	0·59	0·21
Pepperwood	21	32·0	15	195	0·43	0·14
	11	34·7	20	200	0·39	0·14
Queensland walnut ..	43	47·6	15	204	0·38	0·18
	40	46·3	20	195	0·37	0·17
Red tulip oak ..	41	38·2	15	204	0·52	0·20
	38	40·4	20	195	0·73	0·30
Silver ash	20	35·1	15	199	0·81	0·28
	19	33·3	20	200	0·81	0·27
White lauan.. ..	5	37·0	15	201	0·50	0·19
	1	35·1	20	194	0·40	0·14
	2	30·8	20	203	0·66	0·20
	3	34·7	20	198	0·61	0·21
	4	32·0	20	199	0·76	0·24
	6	36·5	20	200	0·57	0·21
	7	31·0	20	204	0·80	0·25
	8	38·2	20	201	0·59	0·23

Again, although fewer data are available, the absorptions on the basis of pounds per cubic foot are similar, although the actual percentages differ materially.

With the 1/8-in. veneer (see Table 8) the average absorptions per cubic foot are less than with the 1/16-in. veneer, the average being about 0.22 lb. per cubic foot. The effect of thickness on diffusion rate undoubtedly causes this difference. Also the variation from the mean is somewhat larger, and with a fixed time interval for treatment the effect of wood structure becomes more evident. With 3/16-in. veneer data on one species only are available, the average absorption for a 30-minute treatment being about 0.18 lb. per cubic foot. It will be seen, with the time schedules used, that there was little difference in absorption between the outside layers and the inside core of the veneers tested.

The fact that there was a fairly general average absorption, when calculated on the basis of pounds per cubic foot, for the different species used, allows of fairly easy control of the treating solution strength, by keeping the solution height constant, using water to make up for evaporation, and adding dry chemical, equivalent to that absorbed by

TABLE 9.—ABSORPTIONS OF BORIC ACID IN TREATED VENEERS.
Veneer thicknesses 3/16-in. and 7/32-in.

Species.	Sample Number.	Average Air-dry Density (lb. per cu. ft.).	Time of Treatment (in Minutes).	Temperature Treatment (° F.).	Percentage of Boric Acid (on Air-dry Wood).	Absorption of Boric Acid (lb. per cu. ft.).
Erima, $^{7}/_{32}$-in. ..	37	20·9	20	200	0·69	0·14
	35 inner	20·4	30	201	0·21	0·04
	35 outer	20·4	30	201	0·53	0·11
White lauan, $^{3}/_{16}$-in.	10	28·0	28	201	0·49	0·14
	36	33·6	30	201	0·48	0·16
	9 inner	35·3	30	207	0·47	0·17
	9 outer	35·3	30	207	0·63	0·22
	34 inner	36·3	30	203	0·42	0·15
	34 outer	36·3	30	203	0·50	0·18
	32 inner	30·1	35	204	0·56	0·17
	32 outer	30·1	35	204	0·63	0·19
	33 inner	35·2	40	204	0·61	0·21
	33 outer	35·2	40	204	0·63	0·22

diffusion in the veneer. The practical details of this are given in the next section. In advocating time schedules for commercial use, it will be noted that for the thinner veneers, the times given are somewhat in excess of those used in the above commercial experimental work. The increased times are designed to cover variations in species and slight variations in cutting, and allow of a slightly greater margin of safety. Their use is advocated on commercial plants where, if anything, the tendency is to shorten, rather than lengthen any given time of treatment. Also it will be noted that timbers are included for which no data are given in this report. In the previous work with sodium fluosilicate a number of different timbers were tested and the results have been interpreted for application to the boric acid treatment.

Veneer treated as outlined above was converted to three-ply using both casein and hot press (Tego-film) glues. With casein glue no difference was noted in adhesion or handling as compared with untreated material. Boric acid veneers, however, could not be satisfactorily bonded with Tego-film. Further laboratory experiments, using an experimental hot press, confirmed the commercial test and showed that when using the standard procedure, very little adhesion was obtained, a chemical reaction apparently occurring between the boric acid and the resin in the glue film. Further laboratory tests are planned, but in the meantime the use of boric acid treated veneers is not advocated with hot press resin glues. Where both casein and hot press glues are in use, the boric acid treated sapwood can be segregated for use with casein glue only. Finishing is not affected.

6. Recommendations for the Commercial Treatment of Green Veneers.

(a) General.

It has been shown, in two previous papers (4, 5), and by other workers (6, 7, 8, 9), that all sapwood is not susceptible to attack. Firstly, it is essential that the pore size of the timber shall be large

enough to allow of the beetle inserting its ovipositor to permit egg-laying. For Australian timbers the minimum pore size required is about 90μ (about 1/300 of an inch). Very few of the commercial species of Australian timbers have a pore size less than 90μ, but, in the case of some of the veneer timbers, this appears to be the case. *Doryphora sassafras* (sassafras) and *Daphnandra micrantha* (sassafras) are typical examples. For general plant work, however, practically all species of timber at present used for veneers may be susceptible to attack. Secondly, the sapwood must contain sufficient starch in order to provide food for development of the Lyctus larvae. The starch content of the sapwood of any particular species may vary considerably and quite often from nil to heavy. Testing of logs for starch before peeling can be easily carried out and is economically sound practice. In the case of some species, as *Elaeocarpus grandis* (blue fig) and *Flindersia oxleyana* (yellowwood), only a small proportion of logs may be susceptible to attack, but obviously the susceptible sapwood in these logs should be treated.

(*b*) *Determination of the starch content of sapwood in the log before peeling or slicing.*

For preference, the starch content of the sapwood in the log should be tested before steaming or boiling. Steaming or boiling causes rupture of the starch grains so that, when iodine is applied to a freshly-cut surface, the resulting bluish colouration is heavier than if tested before steaming or boiling. Actually, testing of steamed or boiled logs is practicable, and if the details as set out later are followed, the only result will be to include for treatment some of the sapwood of some logs which really does not require treatment.

The test for starch should be carried out on the freshly-sawn ends of the log or flitch, on the freshly-cut axed end of a log, or on the radial sections obtained by making an L-shaped cut on the end. This difference in method is due to the fact that, in different species of wood, the starch is present in different wood elements. For timbers like silver ash and pepperwood, the iodine test on the sawn or cleanly-cut end is satisfactory. For some timbers like candlenut or tulip oak, the best results are obtained by making the L-shaped cut with an axe and applying the iodine to the surface showing the ray figure, i.e., the quartered face. It is recommended that the three methods be tried initially with each new species, and that the one which most clearly shows the presence of starch, after testing with iodine, be adopted as the standard method for that species. A weak solution of iodine in water* is applied by means of a spray† to the end surface of the wood, commencing at the outside edge and applying a strip of iodine in as far as the total depth of the sapwood or intermediate wood, i.e., to the truewood. This is necessary, as starch is sometimes found in the inner layers of the sapwood and not in the outer. The test should be preferably made on both ends of the log and at four equally spaced points around the circumference. Where starch is present, the addition of iodine will result in the formation of a bluish or bluish-black colour.

* The iodine solution is prepared by dissolving ½ oz. of potassium iodide in a few ounces of water. When dissolved, add ¼ oz. of iodine crystals and stir till these dissolve. Make up the solution with water to a total of 1 quart. The use of alcoholic iodine solution is unsatisfactory and tinctures should not be used.

† A suitable type of spray is a De Vilbiss No. 17.

Often there is a sharp change from the bluish stain to unstained wood, while sometimes the bluish stain gradually merges away. For practical purposes, any sapwood showing a distinct bluish discolouration within a few minutes of the application of the iodine solution should be treated. The depth to which a well-defined amount of starch is present should be plainly marked by lumber crayon. When subsequently peeled or sliced, all such sapwood should be suitably marked for treatment.

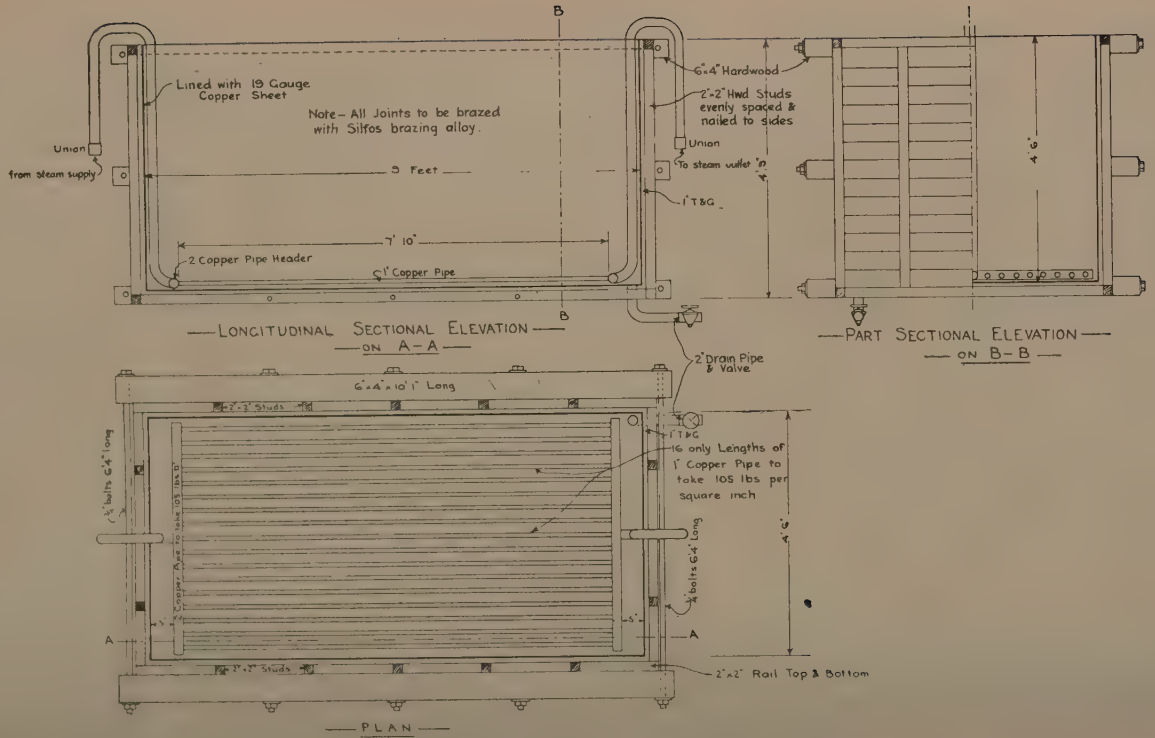
(*c*) *Details of plant required.*

(i) *General.*—On account of the presence of small amounts of tannin in most of the timbers requiring treatment, the use of iron or steel in any part of the treatment tank is unsafe. The slightly acid solution of the chemical, plus the organic acids from the wood, results in solution of some iron which immediately reacts with the tannin in the wood to give a deep bluish-black or ink-like discolouration. This is sufficient to render the treatment of face and back veneers impracticable. Copper appears to be the most suitable material for construction of the treating tank, and its resistance to corrosion by the boric acid treating solution appears to be high. On account of the presence of the boric acid solution, however, it is essential to ensure that only special metals are used in conjunction with it. Brazing of all steam connexions and joints with "Silfos" brazing alloy is strongly advocated.

(ii) *Treatment tank.*—For the treatment of veneer up to 7 feet x 3 feet a tank 9 feet long by 4 ft. 6 in. wide by 4 ft. 6 in. deep is advocated. The tank should be made of 18 or 19 gauge copper sheet, all joints being brazed with Silfos. The copper sheet tank should be supported in a suitably braced wooden box. At the bottom of the tank is fitted a double headed steam coil, this being of copper pipe with brazed joints, details are given in Fig. 2. At one corner of the tank should be included a 2-in. copper drain pipe with valve or cock. A continual supply of steam, preferably at 40 to 50 lb. boiler pressure, is necessary and should be connected as shown, suitable copper joints being provided.

The steam coils should be protected by providing an open wooden structure to carry the weight of the veneer crate and its contents. In the design, the steam coils can be easily removed to enable cleaning of the treating tank, and the suggested method overcomes the disadvantage of joints in the copper sheet tank.

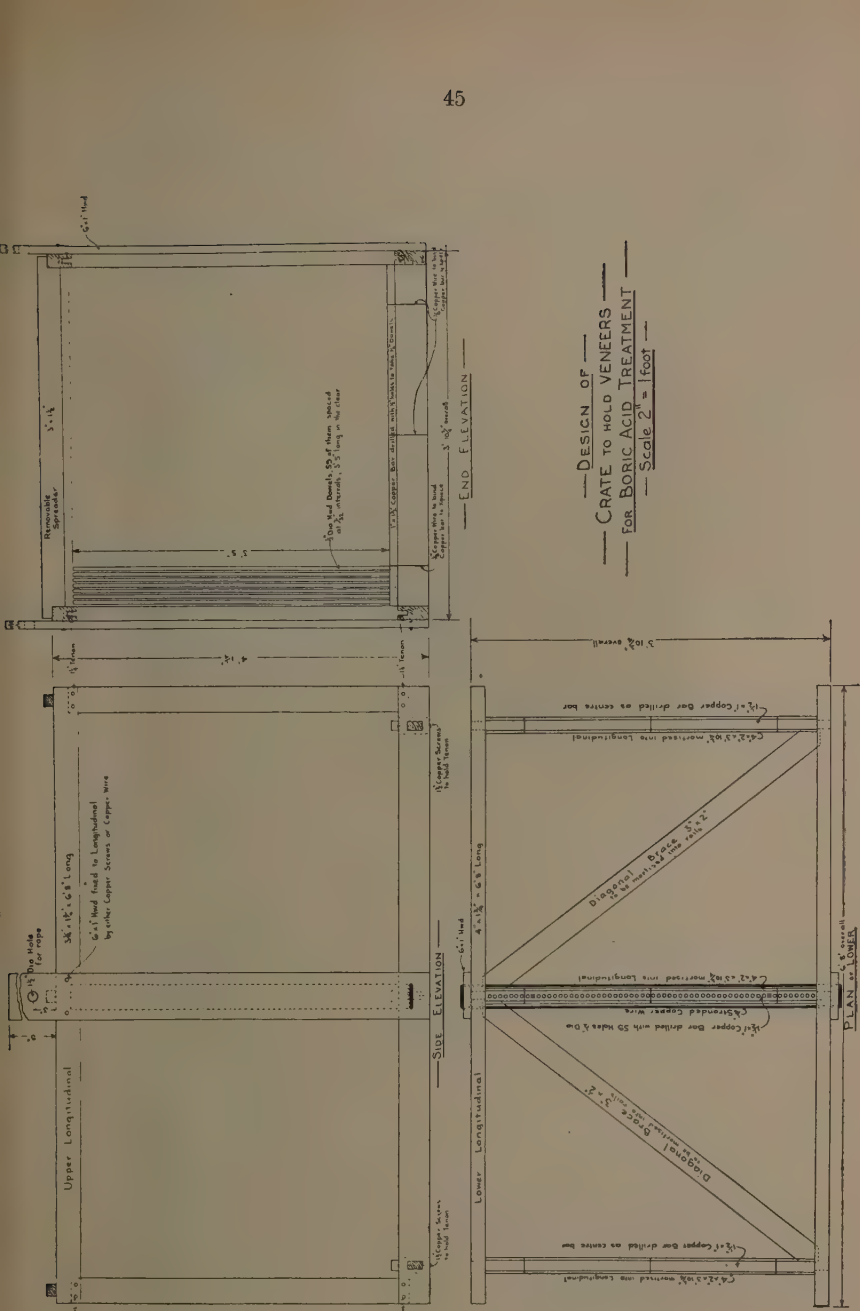
(iii) *Veneer crate.*—It is essential that, during the actual treatment, each sheet of veneer be kept separated. The crate for holding the veneers should be provided with fingers, each veneer sheet being placed between separate fingers. It is suggested that the bottom of the crate be made of timber 4 inches x 2 inches edge on and the fingers of $\frac{3}{8}$-in. diameter copper tubing or $\frac{1}{2}$-in. hardwood dowelling. Part sides should be constructed to allow of the insertion of movable spreaders after loading of the crate so that a rope sling can be used for raising and lowering the crate into the solution (see Fig. 3). It is necessary to provide some means of completely immersing the crate in the solution, the wooden crate and its contents tending to float, and for this purpose, heavy sections of hardwood can be laid on top of the spreaders. All nails or screws used in the construction of the crate should be of copper. A suggested crate to hold 60 sheets of veneer is shown in Fig. 3. The copper bar is of advantage in adding weight and makes a firm bearing for the dowel fingers.



TREATMENT TANK FOR GREEN VENEERS.

Scale 1 inch = 1 foot

FIG. 2.


Design of
Crate to hold Veneers
for Boric Acid Treatment
Scale 2" = 1 foot
End Elevation
Side Elevation
Plan
Upper Longitudinal
Lower Longitudinal
Removable Spreader
Diagonal Brace
Diagonal Brace
Fig. 3.

(d) Preparation of solution.

Boric acid can be obtained as a very fine white crystalline powder, granulated, or as fairly coarse white crystals. The powder is somewhat difficult to wet and thus causes some difficulty in obtaining a solution. The granulated form or the crystals, which are the same price as the powder, are easier to dissolve and handle, and their use is recommended, the granulated form dissolving more easily than the crystals.

The easiest procedure is to fill the treating tank to the required height with water and heat to boiling as quickly as possible. The boric acid required is weighed out and placed in long shallow bags of strong butter muslin. It should not be placed directly in the tank, as it will sink to the bottom and be difficult to dissolve. The muslin bags are made by using two 1-in. squares of timber about 5 feet long. A strip of muslin about 36 inches x 30 inches is taken, and the 36-in. sides bound over and sewn to the middle of the sticks forming a shallow trough. The ends of this trough are then stoutly sewn from the bottom to a height of about 4 to 5 inches. The muslin bag, as constructed, is placed crosswise over the top of the tank, and to the actual bag portion are added the crystals of boric acid. The boric acid is thus kept suspended near the top of the solution, and it can be readily noted when all the material has been dissolved.

The chemical and its solution is not dangerous, and if due care is taken in the way of washing of the hands after handling the solution or freshly treated green timber, no harm will result.

(e) Treatment of veneer.

Veneer should be treated as soon after peeling as possible. It should not be allowed to dry, as dry veneer is more difficult to treat and satisfactory results will not be obtained with the times of treatment given.

After racking of the green veneer in the crate, the whole is immersed in the hot solution. If necessary, weights should be placed on top of the crate to ensure complete covering of the veneer by the solution. These weights should not be of unexposed iron, even if kept above the solution. Care should be taken to prevent iron scale falling in the tank, and, in the event of iron beams being used, they should be well coated with bitumen or other protective coating.

The time the veneer is immersed in the solution depends mainly upon the thickness of the veneer, but also, in cases varies with the species of timber. In Table 10 are given treatment times for some of the veneer timbers at present in use or which may be used in the near future. It should be emphasized that veneer thicker than 3/16 inch cannot be satisfactorily treated. At the expiration of the requisite treating time, the crate and its contents are removed, and the veneer taken out and dried according to ordinary plant practice. The temperature of the solution should be continually tested with a thermometer and not allowed to go below 200° F. Good results are obtained in the range from 200° F. to boiling point (about 214° F.)

(f) Maintenance of solution strength.

During treatment, the boric acid penetrates into the veneer. As a result, there is a reduction in the strength of the solution. If treatment is continued without this reduction being compensated for, then poor treatment results are liable to be obtained. The most satisfactory method for maintaining the correct solution strength is to keep two of

TABLE 10.—TREATMENT SCHEDULES IN MINUTES FOR GREEN VENEER OF VARIOUS SPECIES OF TIMBER, USING A 1.25 PER CENT. SOLUTION OF BORIC ACID AT A TEMPERATURE OF FROM 200° TO 213° F.

Species.	Veneer Thickness.			
	1/20-in.	1/16-in.	1/8-in.	3/16-in.
Amberoi (*Pterocymbium* sp.)	10	15	20	35
Erima (*Octomeles sumatrana*)	8	12	20	30
Northern silky oak (*Cardwellia sublimis*)	10	15	20	35
Pepperwood (*Cinnamonum laubatii* or *C. virens*)	10	15	20	35
Pencil cedar (*Cryptocarya oblata*)	10	15	20	35
Queensland walnut (*Endiandra palmerstoni*)	10	15	20	35
New Guinea walnut (*Dracontomelum* sp.)				
Yellow walnut (*Beilschmiedia bancrofti*)				
Red tulip oak (*Tarrietia argyrodendron* var. *peralata*)	10	15	25	40
Satin sycamore (*Ceratopetalum succirubrum*)	10	15	20	40
Silver ash (*Flindersia pubescens* and *F. schottiana*)	10	15	20	40
Tarzali silkwood (*Cryptocarya oblata*)	10	15	20	35
White birch (Crabapple) (*Schizomeria ovata*)	10	15	20	35
White lauan Borneo cedar Pacific maple Phillipine mahogany (*Shorea* sp.)	10	15	20	35
Yellow carabeen (*Sloanea woollsii*)	10	15	20	35

the muslin bags continually in the treating tank. These can be placed one at either end, and by taking care to keep the veneer sheets square at one end when loading the crate, there is ample room for the crate to enter the solution between the two bags. Boric acid should be added at frequent intervals to the bags so as to ensure the correct solution strength. The solution strength is maintained by the addition of chemical to the hot bath as follows:—

1/20-in. veneer .. Add 8 lb. every 5,000 square feet nominal.
1/16-in. veneer .. Add 10 lb. every 5,000 square feet nominal.
1/8-in. veneer .. Add 15 lb. every 5,000 square feet nominal.
3/16-in. veneer .. Add 18 lb. every 5,000 square feet nominal.

The treating solution should be kept at a strength of 1.25 per cent. The height of solution is kept constant by adding water to make up for evaporation. Evaporation should be reduced to a minimum, especially during lunch hour and overnight, by covering the treating tank with old caul boards or heavy 3-ply.

The above additions are calculated to keep the strength of the solution fairly constant, but some variation will occur and chemical analysis at periodical intervals is essential and must be made to ensure the correct solution strength. An analysis should be made at least every second day, a sample of solution being taken at the end of the last treatment and preferably at least one treatment after the addition of boric acid. As a result of the analysis the necessary adjustment to the treating solution strength can be made by either adding chemical, if too low, or adjusting on the addition of chemical during treatment, if too high.

The method for determination of boric acid is given in Appendix I.; it can be performed by any competent analytical chemist. Solution samples should be preferably analysed on the day they are taken and if necessary the solution strength adjusted immediately.

(*g*) *Effect of extractives.*

It will be found that the boric acid solution, although colourless at first, will increase in colour after treatment of veneer. This is more marked in the case of certain timbers. The colouring matter does not affect the efficacy of the treatment, the only effect being the possible staining of pale-coloured veneer. When the concentration of extractives becomes high enough to cause this, then draining and commencement with fresh solution is desirable. Experience to date indicates that the solution can become saturated with extractives and only cause a surface stain after being used many times. It is suggested that it may be desirable to discard the treating solution after 500 treatments, and to clean out the tank and start afresh.

(*h*) *Effect on veneers.*

The results of commercial tests indicated that the treatment of the green veneers with boric acid as outlined above had no effect on subsequent drying, casein gluing, French polishing, or lacquering, and the colour of the veneer was not affected. It does affect hot press glues, but this problem is being further investigated.

(*i*) *Cost of treatment.*

Boric acid crystals can be purchased on indent in 1 ton lots, c.i.f. capital cities at about £A45 10s. per ton. From stock the cost is about £52 10s. per ton. From the results of the commercial tests in Brisbane, the cost of treatment, including steam cost (which is negligible in most plants), is estimated to be 1s. 2d. per 100 square feet of 3-ply, calculated on a 3/16-in. basis for mixed stocks of veneer thicknesses and based on a crate to hold 60 sheets of veneer. The costs have been apportioned as follows; some of them can definitely be reduced according to facilities available. The use of an electric hoist for raising and lowering the crate is advocated, and its use assumed in the estimated costs.

Cost of treatment per 100 square feet veneer (3/16-in. basis).—Wages 6d., chemical 3d., chemical analyses 1d., steam 1d., overhead 2d., plant depreciation 1d. Total 1s. 2d.

(*j*) *Patent application.*

An application for a patent in respect to the above process has been made on behalf of the Council for Scientific and Industrial Research, and a provisional specification in respect thereof has been accepted by the Commissioner of Patents. For permission to use the process application should be made to the Chief, Division of Forest Products.

7. Acknowledgments.

Grateful acknowledgment is due for the assistance rendered by other officers of the Preservation Section in the carrying out of a considerable portion of the routine analyses and examinations involved. In particular, thanks are due to Mr. H. B. Wilson, B.Sc., and to Mr. J. Gregory.

Acknowledgment is also made of the generous assistance rendered by the Veneer and Plywood Board of Brisbane, and in particular to Messrs. J. F. Brett and R. Bentley at whose mills the commercial experiments with boric acid and sodium fluosilicate, respectively, were made.

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Appendix I.

DETERMINATION OF BORIC ACID IN SOLUTION USED FOR TREATMENT OF VENEER.

Take 10 ml. aliquots of about 1.25 per cent. boric acid solution, in nickel or platinum evaporating basin, add 2.5 ml. of 10 per cent. NaOH, and evaporate to dryness (or nearly to dryness) on a water bath. Ignite the residue for five minutes at a dull red heat until the crystalline residue fuses, and upon cooling, is clean and white.

Dissolve the residue in 10 ml. or less of warm water, and wash with minimum of wash water into an Erlenmeyer flask. Add 2 drops phenolphthalein and then conc. HCl drop-wise until colour fades. Then add 2 drops methyl orange and more conc. HCl until acid to this indicator.

By means of dilute alkali, adjust the solution to the methyl orange end point, and boil gently for fifteen minutes under air reflux condenser, making sure that steam does not issue from the top of the condenser tube. This is to remove the carbon dioxide from solution.

Cool the solution and readjust to m.o. end point. Add a measured amount (approximately equal to one and a half times the volume of solution) of glycerol to the solution, ½ ml. of phenolphthalein and titrate with N/10 standard carbonate free, caustic soda to the phenolphthalein end point.

$$NaOH + H_3BO_3 = NaBO_2 + 2H_2O$$

1 ml. N/10 solution equals 0.00619 g. boric acid.

Correction figure for glycerol to be added if necessary.

Glycerol is often acid in reaction. Various measured volumes of glycerol should be diluted with distilled water of volume approximately equal to the volume of glycerol, and this treated with N/10 NaOH. A slight acidity in the glycerol if not corrected for will indicate a higher concentration of boric acid than that actually present.

A New Technique for Counting Nematode Eggs in Sheep Faeces.

By H. McL. Gordon, B.V.Sc. and H. V. Whitlock.†*

Summary.

Particulars are given of a method whereby this work is simplified and the time required for each sample is reduced by about one-half (from four minutes to two minutes). The method involves the use of a specially prepared slide which is fully described. Such slides can be prepared in the laboratory and may be used repeatedly if simple precautions are exercised in washing them.

1. Introduction.

The method to be described and the special counting chamber slides employed were devised by the junior author (H.W.) who, as a laboratory assistant, has been carrying out routine egg counts during the past three years.

The method formerly used in this laboratory for enumeration of nematode eggs in sheep faeces was a modification of that devised by Stoll‡. Briefly, the technique was as follows:—

> Two grams of faeces, weighed by crumbling into the balance pan, were placed in a glass jar of about 70 ml. capacity; 60 ml. water were added, and the mixture was allowed to stand for a period of 1 to 12 hours (in an ice chest at 4°C. if longer than 4 to 5 hours). To prepare for counting, the mixture was shaken and transferred to a ¼-pint (about 150 ml.) glass cream jar, steel ball bearings (about 50 of 6 mm. diameter) were added, and the jar was corked and thoroughly shaken. A sample of 0.15 ml. was withdrawn with a pipette, placed on a slide, and covered with a ⅝-in. cover slip. By using a mechanical stage, it was ensured that all eggs in the samples were counted. The number of eggs counted, multiplied by 200, represented the number of eggs per gramme of the original faecal sample.

In most cases, duplicate samples could not be dealt with through lack of time, but since daily counts were usually made from the same individual sheep, slight errors from day to day would not be of great consequence.

The disadvantages of this method were:—

(*a*) *Time.*—After long practice (several months) one could complete the process, from mixing the faecal suspension to counting and recording the number of eggs, in about 4 minutes for each sample. It was often necessary to carry out as many as 50 egg counts daily in addition to other routine practices, so that actual mixing and counting occupied about 3 to 4 hours.

(*b*) *Debris obscuring eggs.*—Sheep faeces often contain large amounts of debris which renders observation of eggs difficult, unless one continually changes the focus and intensity of lighting.

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† Laboratory Assistant, McMaster Animal Health Laboratory, Sydney.

‡ Stoll, N. R.—"On Methods of Counting Nematode Ova in Sheep Dung." *Parasitology*, **22**: 116-136, 1930.

2. The New Technique.

The new technique is a combination of sampling and flotation methods. There were numerous modifications before the present method was adopted for routine use.

The technique is as follows:—

Weigh 2 g. of faeces by crumbling into the balance pan, place in a glass jar of about 70 ml. capacity, and add 30 ml. water. This mixture is allowed to stand for varying periods, usually not less than one hour. The longer the mixture stands, the easier is the breaking down of the faeces to a uniform suspension. Actually, counting may proceed after a very short interval—a few minutes—provided sufficient shaking with steel ball bearings is carried out to make a uniform suspension. When ready to proceed with counting, pour the faecal suspension into a suitable thick glass vessel—a cream jar ($\frac{1}{4}$-pint) holding about 150 ml. is generally used. Rinse the glass jar with 30 ml. of the flotation fluid (formerly Sheather's sugar solution was used, but latterly saturated sodium chloride solution, which is cheaper and less "messy" to work with) and pour the rinsings into the cream jar. Add steel ball bearings, cork, and shake thoroughly. A sample is then withdrawn by means of a glass tube with a bore of 8 mm. diameter, with a rubber teat for suction, and allowed to run into a counting chamber on a specially made slide (see Fig. 1). Each chamber will contain about 0.2 ml. of the faecal suspension and has a ruled area which bounds a volume of 0.15 ml. The glass tube is used simply to withdraw the sample and not to measure it. The eggs rise rapidly and come to lie against the under surface of the glass slide which forms the top of the counting chamber. On this under surface is ruled the area which bounds the volume of 0.15 ml. On examination with the microscope, it is found that the eggs are all in the same focus against the slide, while the debris is out of focus on the floor of the chamber.

The size of the area to be traversed in counting the eggs varies according to the depth of the counting chamber. It has been found convenient to have an area of 1 sq. cm., which allows a depth of 1.5 mm. In making the slides, the glass cross pieces (Fig. 1 (3)) were selected by measurement to fulfil these requirements. If the depth is too great (and in consequence the defined area small), the debris interferes with the lighting and renders it difficult to see the eggs without changing the focus and light intensity.

Counting is a rapid process, owing to the relatively small area to be traversed and the absence of the necessity for continual focussing to see the eggs clearly. Not only has the speed with which the egg counting procedure can be carried out been considerably increased, but the whole process has been rendered easier and less tedious. It is now possible to carry out 50 egg counts in about 100 minutes.

The accuracy of this method has been checked against the modified Stoll technique used here formerly, and a close agreement has been found.

There is one disadvantage which is sometimes serious. If there is much dark-coloured faecal debris, it tends to interfere with light coming through the counting chamber and makes it difficult to see eggs

clearly without some change of focus and alteration of light intensity. This trouble has been overcome by using a piece of wire gauze (12 meshes per cm.) across the 8 mm. orifice of the glass tubing used for taking up the samples to be counted. The faecal suspension is drawn in and forced out through the gauze several times before a sample is transferred to the counting chamber. Check tests have indicated that no loss of eggs occurs, in spite of much faecal debris being excluded.

The presence of numerous small air bubbles in the preparation is also a definite disadvantage because the bubbles are in the same focus as the eggs and tend to confuse counting. Practice with the technique, however, especially when introducing the faecal suspension into the counting chamber, enables one to reduce the bubbles to such an extent that they do not interfere with counting. It has been found also that, if the preparations are allowed to stand for about an hour, the majority of the air bubbles disappear.

The special slide.

This is shown in Fig. 1, which is more or less self-explanatory. The glass cross pieces, which support the upper slide bearing the ruled areas, are cut from measured slides. Slides of even thickness are selected and according to this dimension the size of the ruled squares is calculated. The slides at present in use were made by the junior author (H.W.), Canada balsam being used to attach the various sections. In the present routine work (involving 50 to 100 egg counts daily) about 30 slides, each with three counting chambers, are in use. In actual practice, when counts are being carried out daily on the same individual sheep, duplicate counts are not made. It is a simple matter, however, to examine each faecal sample in triplicate, and to use the mean result.

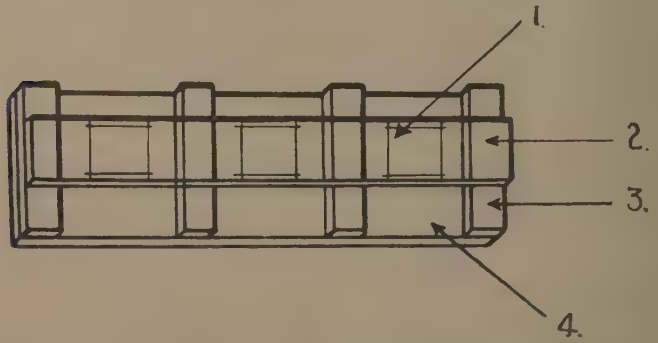

Fig. 1.—1 Ruled area of 1 sq. cm. on under surface of 2. 2. Cover slide 3 Supporting strip 1·5 mm. in thickness 4. Basal slide.

It has recently been found that satisfactory counting chamber slides can be made of stout celluloid, using acetone to cement the pieces together.

Slides are cleaned in cold, running water immediately after use, shaken, and drained by standing on edge. This does not seem to injure the Canada balsam joints, even after constant use. Hot water must not be used, nor must the slides be dried by heat.

Studies on Fly Strike in Merino Sheep.

No. 1.—The Effect of Mules' Operation on the Incidence of "Crutch" Strike in Ewes.

By Dudley A. Gill, M.R.C.V.S., D.V.S.M. and N. P. H. Graham, B.V.Sc.†*

Summary.

This is a detailed account of the results obtained by the operation of crutch-fold removal (known in Australia as the Mules' operation) in the prevention of crutch strike among Merinos. Only those skin folds were removed which were liable to be soiled with urine, and the operation was found to be simple and rapid. The pain inflicted on the sheep is transitory and the wounds heal rapidly. When a treated sheep was struck on the crutch examination showed, in nearly all cases, that further treatment was needed. After this was carried out such sheep were not struck again.

The results, which were excellent, are set out in considerable detail in tables and graphs, and are discussed fully in the text of the article.

1. Previous Observations on Mules' Operation.

Following the published observations of Seddon, Belschner, and Mulhearn (1931) on the relationship of breech folds to crutch strike, Mr. J. H. W. Mules described the surgical removal of these wrinkles in order to reduce the sheep's tendency to urine-staining and consequent strike. It is said that a similar operation had been practised in some stud properties for many years, but had been given no publicity. Mr. Mules' description appeared in the form of a letter to the *Adelaide Advertiser* of 2nd June, 1931, and was repeated in a further letter to the *Pastoral Review* of 16th January, 1932. It is of interest to note that his account refers to the treated sheep remaining free from strike, but it mentions that "ordinary crutching care" was taken in addition to the operation. His description of the procedure is as follows:—"Sit the sheep or lamb as for tailing and remove the hind wrinkles completely from an inch above the vulva to a spot between the legs if they extend that far. After sheep or lambs are done, watch for brown ends and, if any occur, cut off more skin later." The object of quoting this early description is to point out that, at this time, only the removal of crutch folds was involved, and that the need for retreatment in a proportion of cases was recognized.

Bull (1931) saw the operation performed by Mr. Mules and described the histopathological changes in the urine-scalded skin that was removed from the crutch of many of the sheep.

Beveridge (1935) and Mules (1935), gave further accounts of the operation, from which it appears that Mules now considered attention to three other points a necessary adjunct to fold removal for prevention of crutch strike. These points were:—

(1) Cutting of tails on a level with the upper limit of the vulva at lamb marking. This was done to prevent urine from the tip of the vulva soiling the tail, and also to prevent the flattening and deflection of the tip of the vulva which longer tails were alleged to cause.

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(2) Control of "scabby ulcer" at lamb marking, by (*a*) rubbing off the scab and applying copper sulphate, and (*b*) removing the wrinkles and cutting the tails to the length indicated in (1) above.

(3) An operation for straightening the tip of the vulva, when there is sufficient deflection to cause unilateral urine-staining of the breech, although the tail has been cut short. It was suggested that this should not be carried out till some time after marking as many vulvae were said to become straight when pressure from the tail is removed by docking.

Consideration has been given to these three points, and they will be dealt with in a further contribution.

The results obtained in past trials of the fold removal operation were summarized by Mackerras (1937) and need only be referred to briefly here. It appears to us that, while each of them has demonstrated in varying degree the efficacy of the operation, they have not been completely satisfactory from an experimental viewpoint on one ground or another—either because the numbers of sheep or the incidence of strike have not been adequate, or because tail strikes were not differentiated from breech strikes, or no attention was paid to the necessity for retreatment in a proportion of cases. (That this latter is a particularly important point will appear below.)

Recently, an account has been published by Belschner and Hindmarsh (1937) of a trial at Trangie which was commenced in 1935 and continued over two seasons. Two hundred and ninety-eight ewe weaners were divided into three groups having similar numbers of A, B, and C class sheep. On one group the "radical operation" was performed (i.e. all breech folds which could possibly become urine-stained or "sweaty" and excessive tail folds were removed); on another the "modified operation" was used (i.e. only the medial fold was removed and the upper portion of the lateral folds if thought desirable); the third group served as controls.

These authors conclude that the radical operation reduced strike incidence among B's and C's to the level of A's, whereas the modified operation, while rendering B's comparable with A's, still left the C's more liable to strike than A's. No retreatments were carried out, and the fact that 4 out of 23 C class sheep subjected to the radical operation were still classified as C's when re-examined several months later strongly suggests that the results might have been even better had this been done. Unfortunately, in both years during which the sheep were observed following the operation, fly strike was not very prevalent on account of exceptionally dry climatic conditions.

In spite of the various defects in previous trials that have been mentioned above, they have indicated, with one exception, that the fold removal operation materially reduces the incidence of crutch strike. An exception was a trial (Mackerras 1935 and 1937) in which, when the experimental animals were crutched, 10 months after the operation, 20 per cent. of the treated and 25 per cent. of the controls were found to be struck, but as this was the only occasion when strike incidence was recorded, no retreatments were carried out, and no differentiation was made between tail strikes and breech strikes, no conclusion can safely be drawn from it. Moreover, it has been observed that, in seasons when blowflies are exceptionally active and moisture

is abundant, even the plainest of sheep may be struck, and these conditions seem to have existed, at least for a period, during the trial.

During the autumn of 1938, one of us (N.P.H.G.) visited South Australia to enquire into the results obtained by the many pastoralists who had used the Mules' operation on their own flocks. A summary of the report on these observations has since been published by the Australian Wool Board (1938). Briefly, it was found that strike incidence on the whole is considerably lower in South Australia than in many other parts of the continent; this is due largely to the low rainfall throughout most of the Merino sheep country and the plainer type of sheep grown. In most instances no controls had been kept, but the results had been consistently good to a degree that could not reasonably be attributed to chance, and, in those cases in which controls had been kept, this was borne out by a continuance of strikes in the untreated sheep. It was found that the "Rolcut" secateurs, which were advocated as the most suitable instrument for the operation, had been almost entirely replaced by shears, which are at least as efficient and are easier to operate and to keep sharp. Those who had experience of the operation were unanimous that they would apply it, where needed, to all their flock ewes, but opinion was divided regarding its use on studs, some declining to use it at all, but most considering that a distinctive ear mark would enable studs to benefit by the operation while at the same time ensuring that inherently wrinkly breeched ewes could be detected at classing time. Opinion was also divided as to the best time at which to operate—whether at lamb marking or later.

These references to the observations which have already been made on the Mules' operation will serve to introduce the following account of the trial which we have been permitted to conduct at Dungalear.

2. The "Dungalear" Trial of Mules' Operation.

(i) *The arrangement and conduct of the trial.*

The present account covers the results obtained during a completed year; in fact, as shearing in 1938 was delayed on account of drought, the period of observation was nearly fourteen months.

In an interim report of the results obtained during the first three months (Gill and Graham, 1938), the processes used in classifying and grouping the sheep are described, but, for the sake of clarity, the main facts may be re-stated here as follows:—

The experimental sheep comprised 542 six months old Merino ewe weaners and 108 eighteen months old hoggets. They had all been crutched the previous day and were classified into three groups on the grounds of susceptibility to crutch strike, as judged by the extent and position of the breech folds. The numbers in the three groups were:—A's (least susceptible) 40, or 6 per cent.; B's (moderately susceptible) 208, or 32 per cent.; and C's (highly susceptible) 402, or 62 per cent. Each of these groups was divided randomly into two numerically equal sub-groups, on one of which the Mules' operation was performed, the other being retained as a control. In the A class treated sub-group, a section of skin was excised from the site normally occupied by the medial fold. This was not done in the expectation of reducing the susceptibility of the animals to strike, since this was already at a minimum so far as conformation was concerned, but in order that all treated sheep should receive approximately the same treatment and

to provide additional animals on which to note the healing of the wounds and any liability to strike which they might involve.

The 108 older sheep, referred to above, were dispersed evenly throughout the sub-groups. The sub-group to be treated was decided by the toss of a coin. Serially numbered ear tags were used for identification purposes.

Although the basis for classifying sheep into A's, B's, and C's will be discussed more fully in another paper, certain points should be mentioned here. The sheep were classified on the hoof as they moved and stood naturally. We found it much easier to classify them if they were not held, since the unnatural posture adopted by the sheep distorted the folds so as either to accentuate or diminish them. This is particularly so if the sheep are examined when held in the marking position, because of the tension placed on the skin of the crutch when the hind legs are pulled forwards in order to hold them. This fact, incidentally, might lead to inadequate treatment in a percentage of cases.

The operation was performed with "Rolcut" secateurs, the sheep being held across a rail in the normal lamb marking position. The breech folds removed were the medial and, where lateral folds were extensive or the skin on that area was markedly loose, a further excision was made in that situation. Hence the operation carried out at Dungalear corresponded with the "modified" operation as described by Belschner and Hindmarsh (1937). The operation wounds were immediately swabbed with glycerine-diboric fly dressing.

Throughout the trial, the treated and control sub-groups have always grazed together as a single unit. They have been kept under close observation and have been mustered for more detailed examination at fortnightly intervals, all strikes being recorded and dressed.

It was not possible to retain the flock in the same paddock throughout and, largely due to the abnormally dry season, six different paddocks were utilized during the 14 months, but it may be reiterated that at all times the treated and control sub-groups grazed together as a single unit. The conditions as to feed, timber, and surface water (bore drains and dams) varied in the different paddocks, and hence it is likely that the prevalence of blowflies and the consequent exposure to strike risk may have varied at different times during the period of observation.

The climatic conditions at "Dungalear" during the period of the trial were, on the whole, dry. During the spring of 1937, up to the middle of October, the rainfall was only slightly below normal with moderate, well-spaced falls. There was, however, insufficient rain for the growth of any great bulk of feed, so that when dry conditions were experienced during the summer, an acute feed shortage developed. A temporary respite came at the end of January, 1938, when 3 inches of rain fell within a fortnight. This was, however, a period of very high temperatures, and the young pasture soon burnt off. No rains of any value from a pastoral point of view fell from the beginning of February until the end of May. The winter remained dry, but with the lower temperatures feed became established. Good rains fell in the spring of 1938. Although the strike incidence in the spring of 1937 was by no means as high as is sometimes experienced in this district, a third of the sheep in the control group were struck.

During the summer, the weather conditions were extremely hot and dry; at one stage it was thought the experimental sheep would have to

be hand fed. In spite of these conditions, a moderately high strike incidence was experienced during November, December, and the early part of January. Another fly wave was experienced during the autumn, but it faded out following the late autumn crutching in June.

It will be seen from the daily maximum and minimum temperatures given on the graphs that the winter in this area was comparatively mild, 46°F. being the lowest maximum and 18°F. the lowest minimum temperature recorded.

(ii) *Method employed in the dressing of strikes.*

During the first period of the trial (12th July, 1937, to 11th October, 1937), all struck sheep were dressed by a liberal application of glycerine-diborate mixture to the struck area without shearing the wool from it in the usual way. This was done because it was thought that, if strikes were shorn off, the struck sheep would thereby be rendered less susceptible to subsequent strike, and thus the control sheep, among which most strikes were anticipated, would not increase in susceptibility as the wool grew to the same extent as those which had been operated upon, since many of them would have their wool shorn off. Owing to the difficulty in dressing sheep in this manner, it was abandoned after the October crutching and, since then, all strikes have been dressed after shearing off the struck area in the usual way. Judging by the incidence of restrikes, there was no appreciable difference in the efficacy of these two methods. The fly dressing used throughout the trial has been glycerine-diborate.

During the period of the trial, the sheep were machine-crutched on three occasions, viz. 11th October, 1937, 22nd February, 1938, and 5th June, 1938, these crutchings being carried out as part of the normal station routine.

(iii) *Retreatments.*

It was recognized that a small percentage of sheep upon which Mules' operation was performed would require further treatment through the first operation having been inadequate. This would be particularly likely if, at the time of operation, the crutch were severely urine-stained and the skin thickened and inflamed by recent strikes. Under such circumstances, one may inadvertently fail to remove the medial fold completely. It was therefore necessary to re-examine any treated sheep which were struck on the breech, or which showed evidence of urine-staining, to discover whether a second operation was needed.

Among the treated sheep in this trial, 28 were operated on a second time. Only 11 of them had been struck, and the remaining 17 were retreated because folds and urine-staining were still in evidence. Of the 11 which had been struck, 5 retreated at the October crutching and 4 retreated at the February crutching were not struck again, although prior to retreatment they had incurred 15 strikes between them. The other 2 sheep (one retreated in October and the other in February) were struck again despite the second operation. A careful examination in August, 1938, when the trial terminated, showed that yet a third operation was warranted, and it was, therefore, done. (These 2 sheep have not been struck again prior to writing this paper in November, 1938. See footnote on page 64.)

It will be seen in Table 4 below that only 15 of the treated sheep showed pure crutch strikes. Of these, 11 were retreated as has just been described, but the remaining 4 were not treated a second time as the first operation had rendered the breech quite "plain". These 4 sheep only incurred one breech strike each during the year.

3. Results.

The results obtained are tabulated below, but a brief explanation of certain points in connexion with the tables is desirable to avoid any misinterpretation. The first table includes the number of sheep in each sub-group at the commencement of the trial. The fourth column, headed "Present Number", indicates the numbers present at the final examination in August, 1938. The results in this and all other tables omit from consideration those sheep which were dead or missing at the final muster (see third column in Table 1). Of the latter sheep, of which there were 15 among the treated group and 19 among the controls, all but two or three are dead. The cause of death could not be ascertained in most cases, but the relatively high mortality was mainly due to the sheep becoming weak during a drought in the summer and autumn, many of them becoming bogged in tanks, etc. In addition some died during March, when a gastro-intestinal disturbance occurred among the flock, probably due to some toxic plant. It is apparent from the smaller number of deaths among the treated group that the operation itself was not a factor; indeed the first death to occur took place three weeks after treatment when all the resulting wounds were already healed.

Table 1 sets out the totals for all strikes during the period of observation, whether occurring on the crutch or the tail or of doubtful origin (i.e. involving both tail and crutch when first observed, and hence having possibly arisen in either situation). It is apparent, therefore, that this table, while of value in showing the incidence of strike, does not give a true picture of the value of the operation, since some strikes were in such situations that the operation of fold removal could not be expected to prevent them. Chief among strikes of this nature are tail strikes, and these are, therefore, detailed in Table 2.

Table 2 includes all pure tail strikes, irrespective of strikes incurred by the same sheep in other situations. Hence, some sheep noted in this table are also included in Tables 3 and 4. Particular mention is made of this, as it explains why the totals for number of sheep struck in Tables 2 and 3 do not tally with the corresponding figures in Table 1. It will be noticed that more tail strikes occurred among the control sheep than among the treated. This difference, however, is not statistically significant, and the number of strikes per struck sheep is practically the same in both groups.

Table 3 includes pure crutch strikes, together with all those strikes which involved both tail and crutch when first seen, and which may have originated in either of these two situations. This table, therefore, includes every strike that could conceivably have been affected by the operation. Table 4 includes only those strikes which were confined to the crutch area, that is to say, the type of strike for the prevention of which the operation of fold removal is particularly intended. It therefore shows the maximum results attributable to the Mules' operation, so far as this trial is concerned, whereas Table 3 shows the minimum.

TABLE 1.—TOTAL STRIKES, JULY, 1937–AUGUST, 1938.

Classification.	Treated Group.						
	Original Number.	Dead or Missing.	Present Number.	Number of Sheep Struck, All Positions.	Percentage of Sheep Struck.	Number of Strikes, All Positions.	Strikes per Struck Sheep.
A	20	..	20	1	5·0	1	1·0
B	104	3	101	9	8·9	11	1·2
C	201	12	189	48	25·4	85	1·8
Total ..	325	15	310	58	18·7	97	1·7

TABLE 1.—*continued.*

Classification.	Control Group.						
	Original Number.	Dead or Missing.	Present Number.	Number of Sheep Struck, All Positions.	Percentage of Sheep Struck.	Number of Strikes, All Positions.	Strikes per Struck Sheep.
A	20	1	19	..	..	..	..
B	104	3	101	41	40·6	92	2·2
C	201	15	186	138	74·2	576	4·2
Total ..	325	19	306	179	58·5	668	3·7

TABLE 2.—TAIL STRIKES, JULY, 1937–AUGUST, 1938.

Classification.	Treated Group.				
	Number in Group.	Number of Sheep Struck on Tail.	Percentage of Sheep Tail Struck.	Number of Strikes on Tail.	Tail Strikes Per Struck Sheep.
A	20	1*	5·0	1	1·0
B	101	5*	4·9	7	1·4
C	189	30*	15·9	43	1·4
Total ..	310	36	11·6	51	1·4

TABLE 2.—*continued.*

Classification.	Control Group.				
	Number in Group.	Number of Sheep Struck on Tail.	Percentage of Sheep Tail Struck.	Number of Strikes on Tail.	Tail Strikes Per Struck Sheep.
A	19	..	..	..	..
B	101	15*	14·9	18	1·2
C	186	40*	21·5	52	1·3
Total ..	306	55	18·0	70	1·3

*Includes all pure tail strikes irrespective of any other strike the sheep may have had. The higher incidence of tail strikes among the control sheep is not statistically significant.

TABLE 3.—CRUTCH STRIKES, PLUS STRIKES OF DOUBTFUL ORIGIN,* JULY, 1937–AUGUST, 1938.

Classification.	Treated Group.				
	Number in Class.	Number of Sheep with Crutch Strikes or Strikes of Doubtful Origin.	Percentage of Sheep with Crutch or Doubtful Origin Strikes.	Number of Strikes on Crutch and of Doubtful Origin.	Strikes Per Struck Sheep.
A	20	..	..	..	..
B	101	4	3·9	4	1·0
C	189	25	13·2	42	1·7
Total ..	310	29	9·4	46	1·6

TABLE 3.—*continued.*

Classification.	Control Group.				
	Number in Class.	Number of Sheep with Crutch Strikes or Strikes of Doubtful Origin.	Percentage of Sheep with Crutch or Doubtful Strikes.	Number of Strikes on Crutch and of Doubtful Origin.	Strikes Per Struck Sheep.
A	19	..	..	..	..
B	101	35	34·6	74	2·1
C	186	129	69·4	524	4·1
Total ..	306	164	53·6	598	3·6

*Strikes of doubtful origin are those which involved both tail and crutch when first observed, and which may have originated in either of these two situations.

TABLE 4.—STRIKES INVOLVING CRUTCH ONLY, JULY, 1937–AUGUST, 1938.

Classification.	Treated Group.				
	Number in Class.	Number of Sheep Struck on Crutch.	Percentage of Crutch Struck Sheep.	Number of Strikes on Crutch.	Strikes Per Struck Sheep.
A	20	..	..	..	..
B	101	1	1·0	1	1
C	189	14	7·4	22	1·5
Total ..	310	15	4·8	23	1·5

TABLE 4.—*continued.*

Classification.	Control Group.				
	Number in Class.	Number of Sheep Struck on Crutch.	Percentage of Crutch Struck Sheep.	Number of Strikes on Crutch.	Strikes Per Struck Sheep.
A	19	..	..	..	..
B	101	29	28·7	57	2·0
C	186	121	65·0	448	3·7
Total ..	306	150	49·0	505	3·4

An easier appreciation of these results is provided by the following summary (Table 5) of the totals for "number of sheep struck" and for "number of strikes" taken from the above tables, to which has been added the ratio of strikes among treated sheep compared with strikes among control sheep.

TABLE 5.

	Total Strikes.		Tail Strikes.		Crutch and Doubtful.		Crutch Only.	
	Number of Sheep Struck.	Number of Strikes.	Number of Sheep Struck.	Number of Strikes.	Number of Sheep Struck.	Number of Strikes.	Number of Sheep Stuck.	Number of Strikes.
Treated 310 ..	58	97	36	51	29	46	15	23
Controls 306 ..	179	668	55	70	164	598	150	505
Ratio of strikes among treated sheep: strikes among controls ..	1 : 7		..	1 : 1·4	..	1 : 13	..	1 : 22

It is seen from this that there were at least 13, and at most 22, crutch strikes to be dressed among the control sheep for every 1 among the treated.

Finally, as regards the results, it is desirable to compare those obtained with "B" class and "C" class sheep separately. This may give an indication of the benefit which can be expected, under average conditions, in flocks with varying degrees of crutch development, whereas the total results would be applicable only to flocks resembling that at Dungalear. The figures for the control group in Table 3 indicate that the C's were about four times as liable to be struck as the B's, and hence the operation might be expected to have a more spectacular effect on C class sheep than on those of the B class. Whether that is so or not depends on the way in which the figures are considered. Taking actual strikes (again from Table 3), it is seen that there were 524 among the C class controls compared with 42 among the C class treated—a reduction of 482, whereas among the B class sheep the reduction was from 74 to 4, namely 70. But when one considers the ratios of strikes, it is found that, whereas among the C class sheep there were 12.5 strikes among the controls for every one among the treated, in the B class sheep there were 18.5 strikes among the controls for every one among the treated sheep.

This point has been elaborated because the interim report on this trial raised the criticism that pastoralists with plainer flocks would be misled into thinking Mules' operation would give equally spectacular results with their sheep as it had given at Dungalear. What has been said above should suffice to show that, while results in plainer flocks may not appear so good at first sight, there is reason to suppose that, actually, they will be as good or better, when due allowance is made for the lower initial strike incidence.

The following graphs show the incidence of strike throughout the trial and its relation to crutching. They include also the data regarding rainfall and temperature during the trial. While the three crutchings were necessary in order to control strike among the untreated sheep, the graphs strongly suggest that a single mid-season crutching would have served to keep strike within reasonable limits so far as the treated sheep were concerned. To demonstrate this important practical point still further, Table 6 has been prepared, showing the period which elapsed between crutching and the first recorded strike in the various sub-groups.

TABLE 6.

Date of Crutching.	Time in Days Before First Strike Recorded.			
	B. Treated.	B. Control.	C. Treated.	C. Control.
11th July	81	27	30*	20
11th October	72	44	44	15
22nd February	104†	35	66	11
5th June to shearing (= 83 days)	None Struck	82	None Struck	45

* Most of the treated sheep struck prior to 11th October required re-treatment. Some of these sheep were very susceptible until the remnants of folds were removed.

† Tail strikes only occurred in this group prior to 5th June.

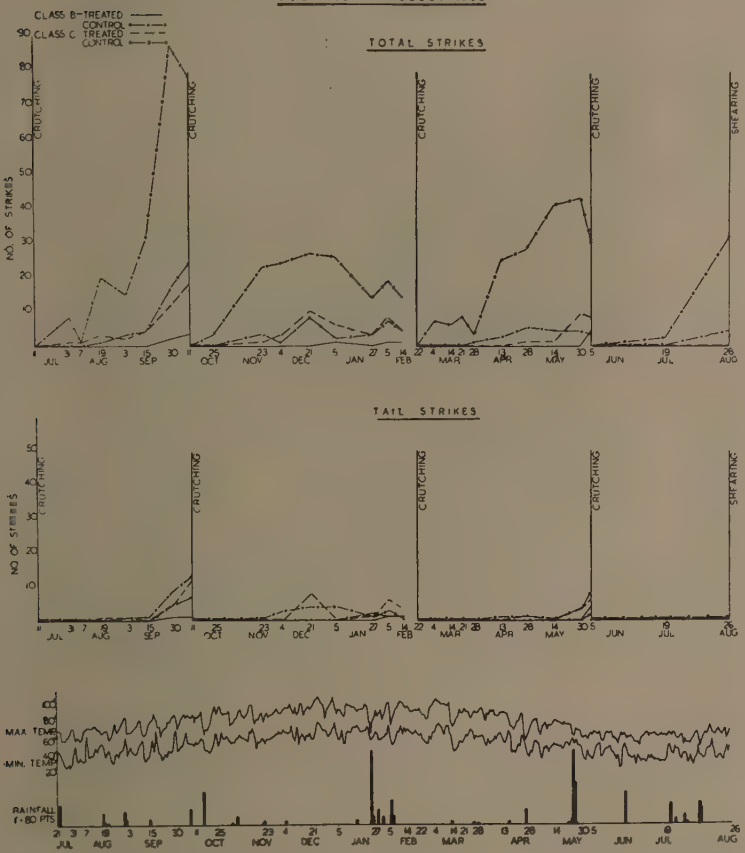
Another point which emerges from the graphs, and which cannot be shown in tables, is the decline in the crutch strike incidence among the treated sheep resulting from the further treatments carried out in October and February on those which had been struck since the trial commenced. Actually, from 22nd February, 1938 (by which date were completed all re-treatments which could affect these results), to 26th August, 1938, when this phase of the trial terminated, there were 185 crutch strikes and 44 strikes of doubtful origin among the control sheep compared with 4 and 6 strikes, respectively, among the treated sheep. For this period, therefore, the ratios of crutch strikes plus strikes of doubtful origin, and for crutch strikes only, in the treated and control groups, were:—1:23 and 1:46, compared with similar ratios for the whole period of 1:13 and 1:22. The need for attention to be paid to re-treatment in a proportion of cases, and the additional benefit derived from it is thus very clearly shown.*

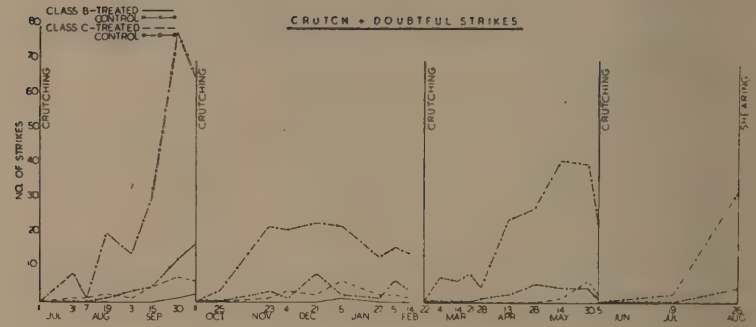
The value of the Mules operation may also be indirectly assessed by comparing the breech classifications before and after the operation. This comparison is shown in Table 7.

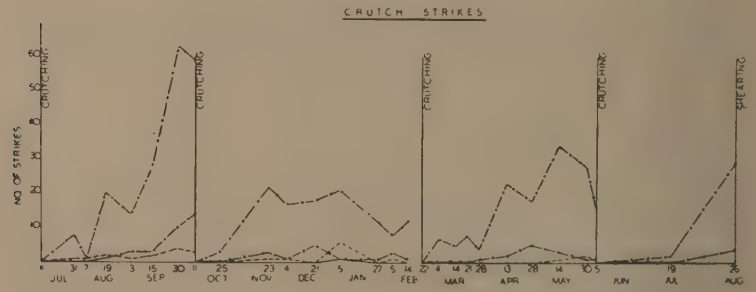
* To stress still further the need for re-treatment, the strike figures from shearing on 22nd August, 1938, to crutching on 7th November, 1938, showed that there were 70 crutch strikes and 13 strikes of doubtful origin in the control group and none in the treated group. For the period 22nd February to 7th November, the ratios of crutch strike plus strike of doubtful origin, and for crutch strike only, in the treated and control group were:- 1:31 and 1:64.

FLY STRIKE INCIDENCE, DUNGALEAR

JULY 1937 — AUGUST 1938




CLASS B-TREATED
CONTROL
CLASS C-TREATED
CONTROL
CRUTCH + DOUBTFUL STRIKES
NO. OF STRIKES
CRUTCHING
SHEARING
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG


CRUTCH STRIKES
NO. OF STRIKES
CRUTCHING
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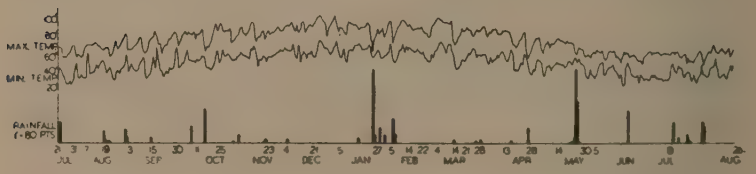
MAX. TEMP.
MIN. TEMP.
RAINFALL (·80 PTS.)
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG

TABLE 7.

Effect of Mules' Operation on Crutch Classification.

Treated Groups.					Control Groups.				
Original Classification.	Reclassification.				Original Classification.	Reclassification.			
		A	B	C			A	B	C
A	20	20	0	0	A	19	18	1	0
B	100	98	2	0	B	101	21	68	12
C	188	178	8	2	C	186	4	70	112

It is seen, therefore, that of 288 B and C class sheep at the original classification, all but 12 (4 per cent.) were converted to the A class by the operation. No further reclassification has been made since re-treatments were completed.

Table 7 reveals also that, as would be expected, B class sheep are more consistently converted to the A class by the operation than are C class sheep. It must be remembered that, as practised in this trial, the operation was of the "modified" rather than the "radical" kind (Belschner and Hindmarsh, 1937). The reclassifications were undertaken in our presence by Dr. Mackerras, some six months after operation. A discrepancy between his classification and ours is apparent in the control group. It probably resulted from a combination of three factors—the personal factor, slightly different procedure on the two occasions, and possibly some change in the conformation of the sheep themselves. As regards the latter, most of the sheep were only six months old at our original classification, and it is possible that some change in the degree or prominence of their breech wrinkles had occurred subsequently. Whether such changes do, or do not, occur has never been definitely established, though field observations have often suggested it, and Belschner (1937) refers specifically to sheep which he classified as "B's" being put into the A class when he examined them again some months later.

4. Discussion.

(i) *Technique of the operation.*

Mules' operation has been described by several workers on previous occasions, including Beveridge (1935), Mules (1935), and Belschner and Hindmarsh (1937). At Dungalear Mr. Mules used "Rolcut" secateurs, which at that time were thought to be the most desirable instrument. We found, however, that they were very difficult to keep in good cutting order and tiring to use, and we have since used shears, which, if well sharpened, prove an excellent instrument. We have found it convenient to keep a pot of lysol solution available for the operator to dip the shears into between sheep. This prevents gross contamination of the blades by dried blood and dust. A box or bucket into which the strips of skin can be thrown facilitates their removal from the operating yard.

When the sheep are held over the rail, the tendency is for the wrinkles to be pulled out so that the operator must make due allowance for this, and he should tend to overtreat rather than undertreat the sheep as they appear before him. Sheep, which may appear plain on the rail, may reveal well-developed wrinkles when they are standing normally.

Normally, the wounds heal very rapidly, though the sheep may remain a little stiff in the hind quarters for one or two weeks. The wounds do not appear particularly attractive to blowflies, but nevertheless there is always a danger of strike if the operation is carried out during those periods of the year when fly strike is particularly prevalent. In any case, if done during the summer months, the sheep become severely irritated by the swarms of small bush flies (*Musca vetustissima*) which cluster around the wounds. The risk of bacterial infection is also greater during the warmer months, and, when it appears, may be carried rapidly from sheep to sheep by flies.

After some experience with the procedure of the operation, it should be possible to do at least 100 sheep per hour, provided an adequate number of catchers is available.

If carried out at marking time, the operation is easier for all concerned, but the amount of wool on the breech of the older lambs renders the extent of the wrinkles harder to define and hence a larger percentage is apt to require retreatment. If the operation is carried out later less re-treatment is needed, but it is a little more laborious on account of the increased size and weight of the animal, and it must be done soon after a crutching has taken place (see Plate 2, Figs. 3 and 4). When crutching is carried out at weaning time, the Mules operation can conveniently be done then, but in practice the time selected will depend a good deal on local circumstances. For example, except where lambing takes place in the autumn, the lambs are still with the ewes during those periods when fly strike is most troublesome, and hence serious losses may occur between marking and weaning. In such instances there is obviously a strong case for carrying out the Mules' operation at marking time, even though it may involve a high percentage of re-treatments later on.

(ii) *Indirect effects.*

Apart from reducing the incidence of crutch strike, Mules operation makes crutching more efficient. This was clearly seen when the sheep were examined just after crutching, the treated sheep being quite clean, whereas the controls often had pieces of urine-stained and matted wool up to three-quarters of an inch long left in the folds around the vulva. The crutching process was noted to be easier, quicker, and more efficient, and the number of wounds inflicted on the crutch was very considerably reduced.

Mackerras and Fuller (1937) found that crutch strikes accounted for 90 per cent. of over 1,400 strikes examined by them, and the results we have obtained, together with those given by Seddon and Belschner (1935) and Belschner and Hindmarsh (1937), show conclusively that Mules' operation offers a very valuable method of prevention. Moreover, according to Mackerras (1936), whereas over

1,000 primary flies have been bred from a natural breech strike at Canberra, less than 100 were bred from a sheep's carcass. As this provides a factual basis for the present belief among many research workers in this field that the most important breeding ground for primary sheep blowflies is the *living* struck sheep, it is, *ipso facto*, at least possible that the widespread use of Mules' operation would materially reduce the blowfly population and hence have an indirect effect on the total strike incidence. Since strikes result from the presence of susceptible sheep within the orbit of blowflies, it follows that the smaller the blowfly population the greater chance has a susceptible sheep of escaping strike. Hence the contention of Mr. Mules that even better results could be expected in a flock where no untreated control group was maintained, is not without reason, but unfortunately no conclusions would be permissible from an uncontrolled experiment.

As concerns the economic value of this operation to the pastoralist, there is not only a great saving in labour and cost of fly dressings, but extensive fly strikes involve considerable losses through wool which is shorn off strikes dressed in the paddock or yards, and the frequent yarding of sheep for fly dressing lowers the commercial value of the fleece through increasing its content of dust. The effect of strike on body weight, on the quantity and quality of wool, and on reproduction, will be dealt with in another article, using data derived from the Dungalear trial.

(iii) *Effect upon the sheep.*

Mules' operation has been criticized in some quarters on the grounds of cruelty. From our experience, the pain caused by the operation is only momentary, and sheep generally walk quietly away and feed immediately they are released. The pain endured during the operation cannot be as severe as that involved in castration, nor can it compare with the obvious wretchedness induced by the constant irritation and fever resulting from an active strike.

(iv) *Extent of the operation.*

It has been claimed that buyers may be deceived through this operation and may purchase inherently wrinkly breeding ewes under the impression that they are plain sheep. It has been our experience that many pastoralists who have not seen the operation have quite a wrong impression of the extent of fold removal which is required to give results. It is for this reason that Plate 2, Figs. 1 and 2 are included. One shows a badly urine-stained C class sheep, and the other a sheep that was originally in a similar state but which was treated some six months previously and had just been crutched. The only area involved in the operation, as we practised it, is included within the central part of the crutch around the vulva and is clearly shown in this photograph (Pl. 2, Fig. 2) through its light colour. The removal of the folds from this small area cannot disguise the fact if the animal is, in general, of a wrinkly type. It cannot be denied that people who wish to deceive their fellow graziers can convert a wrinkly breeched sheep into a plain one by cutting off all the wrinkles from the breech area, but, if anyone were prepared to go to such lengths to deceive a buyer, it would be difficult to prevent in any case.

(v) *Crutch folds and urine-staining.*

Lastly, there has been some debate, ever since the system of classifying sheep on the basis of crutch fold development was first introduced, as to why some C class sheep escape being struck in spite of extensive folds in close proximity to the vulva. With this in mind we carefully examined all the C class sheep which had not been struck during the period of the trial, and it was most noticeable that they were all completely free from any sign of urine-staining. This was particularly striking when they were sorted out and compared with the C class sheep which had been persistently struck, all of which showed the crutch area to be deeply stained, matted, and foul. No explanation could be discovered for the escape of these sheep from the urine-staining which was so pronounced in the others. The conformation of crutch, vulva, and tail was not noticeably different in the two groups. It was apparent from observations of the act of urination in these ewes, however, that factors other than external conformation may play a very large part. Trifling anatomical differences in the position and conformation of the urinary meatus, for example, would greatly affect the direction and force of the stream of urine. Moreover, the efficiency of the nervous control of urination may determine whether the act ceases abruptly or so slowly as to permit the escape by gravity of small quantities of urine after the ewe has returned to the normal standing posture.

5. Conclusions.

(1) The Mules operation of crutch-fold removal, properly performed, is highly successful as a means of reducing the incidence of crutch strike.

(2) The operation is easily and quickly performed, causes only transitory pain, and the wounds heal with remarkable rapidity. While the wounds in themselves do not appear to be attractive to blowflies, the operation should not be performed during a period when blowflies are actively striking the sheep, nor in the summer months when the wounds are liable to serious irritation from bush flies (*Musca vetustissima*).

(3) While the operation may have an indirect effect on the general strike incidence through reducing the breeding grounds of primary flies, it cannot be expected to have any direct effect on strikes in other situations than the crutch. Hence tail strikes should be excluded when considering the efficacy of the operation.

(4) In a carefully controlled experiment involving 650 sheep, over a period of fourteen months, there were at least 13, and at most 22, crutch strikes among the control sheep for every one such strike among those which were treated.

(5) Attention to the need for retreating a small percentage of sheep that are not adequately dealt with on the first occasion is clearly demonstrated. When allowance was made for this factor the ratios given under (4) above rose from 13 : 1 and 22 : 1 to 23 : 1 and 46 : 1 respectively (see also footnote on page 64).

6. References and Acknowledgments.

(Acknowledgments and references to the literature which has been cited are included in No. 2 of this series—see page 82.)

Studies on Fly Strike in Merino Sheep.

No. 2.—Miscellaneous Observations at "Dungalear" on the Influence of Conformation of the Tail and Vulva in Relation to "Crutch" Strike.

By Dudley A. Gill, M.R.C.V.S., D.V.S.M., and N. P. H. Graham, B.V.Sc.†*

Summary.

This study deals with factors, other than the presence of crutch folds, which were said to increase susceptibility to fly strike about the breech area.

It was found that the minor degrees of vulvar deflection, which are commonly encountered among ewes, have no relationship to strike incidence, and the available evidence also refuted the belief that sheep should be docked short. While further accurate observations are required to determine the best principles to follow when docking lambs, observations detailed below suggest that less trouble from fly strike is to be anticipated from docking the tail long than from cutting it too short.

A very close association was noted between the extent of crutch fold development and tail fold development.

Based on the data presented in this and the preceding study, the opinion is expressed that, if rightly applied, the use of Mules' operation need not conflict with a policy of breeding away from an undesirably wrinkly type of Merino. The two practices should be regarded as complementary to each other, not as alternatives.

I. Observations on the Tail and Vulva in Relation to "Crutch" Strike.

In the later accounts of the Mules operation (Beveridge, 1935, Mules, 1935, and Mackerras, 1936) to which reference is made in No. 1 of this series, the operation is divided into four parts, viz.: (1) removal of wrinkles, (2) treatment of "scabby ulcer" of the vulva, (3) straightening deflected vulvae surgically, and (4) cutting the tail short, i.e., above the upper commissure of the vulva. Our observations on (1) provided the subject matter for the first of this series of studies of fly strike.

It was contended that the other three procedures were valuable in lowering the incidence of fly strike because they reduced urine-staining. The hypothesis was that the "tip" of the vulva in sheep is normally long and straight and drains urine away from the wool on either side of the vulva, and that if, for any reason, the tip of the vulva becomes shortened, or deflected to the right or left, the urine is drained on to the wool, instead of away from it, and the consequent increase in wetting is associated with an increased susceptibility to fly strike. It was considered that the tip of the vulva might become shortened or deflected by two means, one a condition called "scabby ulcer"—a chronic ulcerous condition of the tip of the vulva described by Seddon, Belschner, and Mulhearn (1931)—and the other, shearing or crutching wounds. In addition, it was thought that a long tail, pressing on the vulva, may cause the tip to become permanently deflected to one side or the other.

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Beveridge (1935), having examined the vulvae of some 800 sheep, found that in 20 per cent. the tip of the vulva was deflected to the left and in only 8 per cent. to the right. He also examined 500 strikes, 45 per cent. of which occurred on the left side of the crutch and 20 per cent. on the right. Similar figures were obtained in 213 strikes observed by Carter and Belschner 1937), 41 per cent. being on the left side and 32 per cent. on the right.

As these two observations seemed to support Mules' contention, it was decided to carry out observations on the "Dungalear" sheep to see if there was any correlation between—

(1) The length of the tail and deflection of the vulva.
(2) The length of the tail and crutch strike.
(3) The length of the tip of the vulva and crutch strike.
(4) Deflection of the vulva and crutch strike.

(1) *Correlation between the length of the tail and deflection of the vulva.*

For this purpose the sheep were divided into three tail length groups, namely—

"Long"—in which the tail extended below the tip of the vulva.

"Medium"—in which the tail extended below the upper commissure, but not below the tip of the vulva.

"Short"—in which the tail was cut off above the upper commissure.

The percentage of sheep in these three groups having the tip of the vulva deflected to the right or to the left is shown in Table 1 below, the sheep from both the control and treated groups (see previous paper) being used in its compilation.

TABLE 1.—TAIL LENGTH AND VULVAR DEFLECTION.

Tail Length.	Number of Sheep.	Vulva Deflected Left.		Vulva Straight.		Vulva Deflected Right.	
		Number Sheep.	Percentage of Tail Group.	Number Sheep.	Percentage of Tail Group.	Number Sheep.	Percentage of Tail Group.
"Long" ..	61	24	39·3	28	45·9	9	14·8
"Medium" ..	157	60	38·2	72	45·8	25	15·9
"Short" ..	397	134	33·7	192	48·3	71	17·9

While collecting particulars of the vulvae and vulvar deflections among these sheep, it was observed that there was a somewhat greater tendency for vulvae with a long "tip" to be deflected than was the case with those on which the "tip" was of medium length or short (i.e., practically non-existent). This is shown in Table 2.

Table 2.—Length of Vulvar Tip and Vulvar Deflection.

Length of Vulvar "Tip."	Vulva Straight.		Vulva Deflected.	
	Number Sheep.	Percentage of "Tip" Group.	Number Sheep.	Percentage of "Tip" Group.
Long Tip	70	40·0*	107	60·0*
Medium Tip	145	50·0	146	50·0
Short Tip	77	52·3*	70	47·7*

* These differences are not statistically significant.

Because of this finding, a further check was made to determine whether this could have influenced the results shown in Table 1 above. It was found, however, that there was approximately the same number of vulvae having long, medium, and short "tips" in each of the three tail length groups.

It is apparent, therefore, that, so far as the "Dungalear" sheep were concerned, tail length was not a factor in vulvar deflection.

(2) *Correlation between tail length and crutch strike.*

For the purpose of examining this association, sheep from the control group only were examined, since there were insufficient strikes among the treated groups to warrant their inclusion. These were divided into their tail-length groups, and the number of pure crutch strikes in each group determined as set out in Table 3.

Table 3.—Tail Length and Crutch Strike Incidence.

	Number Sheep.	Struck on Crutch.	Percentage Sheep Struck.	Number Strikes.	Strikes per Struck Sheep.
Long Tail	31	9	29·0*	27	3·0
Medium Tail	93	42	45·2	111	2·7
Short Tail	182	99	53·6*	268	2·7

* This difference is statistically significant.

From Table 3 it will be seen that in these sheep it was not the long tails but the short ones that were associated with the greatest incidence of crutch strike, although the degree of susceptibility among the sheep that were struck in each tail length group (as judged by the number of strikes per struck sheep) was approximately the same.

It was thought that these results might have been due to a higher proportion of B and C class sheep in the shorter tail groups, but on investigating this possibility it was found that the proportions of A, B, and C class sheep in each tail length group were practically identical.

We could find no obvious explanation for the higher crutch strike incidence in the short tail groups.

(3) *Correlation between vulvar length and crutch strike.*

We understand that the advice to control "scabby ulcer" is based mainly on the belief that this condition causes erosion of the vulvar tip, which, in turn, by reducing the length of the tip, may lead to increased urine-staining of the crutch.

To examine, therefore, whether there was any association between the length of the tip of the vulva and the incidence of crutch strike, the sheep in the control group were arranged in three groups according to the length of the tip of the vulva, and the incidence of crutch strike was determined in these groups. Only undoubted crutch strikes were considered, any strike of doubtful origin being excluded. The results are shown in Table 5.

TABLE 5.—ASSOCIATION OF THE LENGTH OF THE TIP OF THE VULVA WITH CRUTCH STRIKE (CONTROL GROUP ONLY).

—	Number of Sheep.	Number of Sheep Struck.	Percentage of Sheep Struck.
Long tip	92	42	45·6
Medium tip	130	69	51·9
Short tip	84	39	46·4

The proportions of A, B, and C class sheep in the three "tip" length groups were found to be practically identical. It will thus be seen that the length of the tip of the vulva had no effect on the incidence of crutch strike.

(4) *Correlation between deflexion of the vulva and crutch strikes.*

The sheep in the control group were arranged in three groups according to whether the vulva was deflected to the left, was straight, or was deflected to the right, and the incidence of pure crutch strike in the three groups determined. The results are shown in Table 6.

TABLE 6.—DEFLECTION OF THE VULVA AND CRUTCH STRIKE.

—	Number of Sheep.	Number of Sheep Struck.	Percentage of Sheep Struck.
Vulva—Deflected left ..	119*	55	46
„ Straight	138	75	54
„ Deflected right ..	49*	20	40

* This difference is statistically significant.

It will be seen from the above table that nearly two and a half times as many sheep had the vulva deflected to the left as to the right, which agrees well with the figures given by Beveridge (1935). The strike incidence in the two deflected groups, is, however, slightly lower than in the straight group—hence deflection of the tip of the vulva did not appear to predispose these sheep to fly strike.

In view of the higher incidence of crutch strike on the left side than the right, and since the tip of the vulva is more often deflected

to the left than to the right, it was decided to analyse the crutch strike figures further in order to determine whether or not these two facts were in any way related to each other, as was suggested by Beveridge (1935).

The sheep were therefore grouped according to the deflection of the tip of the vulva, as in Table 6, and divided into three sub-groups according to the side of the crutch on which they had been struck. In Table 7 below, the "left-side" group comprises all those sheep which were struck on the left side of the crutch only, or on the left side and both sides only, i.e., they have never been struck on the right side only. The "right-side" group is similar to the above except that they were never struck on the left side of the crutch only. The third group, or "both sides" group, were struck on both the left and right sides on different occasions.

Table 7.—Strike Location and Vulvar Deflection (Struck Sheep).

—	Tendency to Left Side.		Tendency to Both Sides.		Tendency to Right Side.	
	Number Struck Sheep.	Percentage Struck Sheep.	Number Struck Sheep.	Percentage Struck Sheep.	Number Struck Sheep.	Percentage Struck Sheep.
Vulva—Deflected left ..	28	50·9*	22	40·0	5	9·1*
,, Straight ..	35	46·6†	31	41·4	9	12·0†
,, Deflected right ..	8	40·0‡	9	45·0	3	15·0‡

* † ‡ These differences are statistically significant.

It is apparent, therefore, that irrespective of the side towards which the vulva was deflected, these sheep had a greater tendency to be struck on the left side than on the right. Even among the sheep showing vulvar deflection to the right, there were nearly three times as many struck on the left side as on the right.

A similar result was obtained when the total number of strikes on the different situations was compared, as set out in Table 8.

Table 8.—Strike Location and Vulvar Deflection (Strikes).

—	Strikes Involving Left Side Crutch.		Strikes Involving Both Sides Crutch.		Strikes Involving Right Side Crutch.	
	Number Strikes.	Percentage Strikes.	Number Strikes.	Percentage Strikes.	Number Strikes.	Percentage Strikes.
Vulva—Deflected left ..	86	47·7	65	36·1	29	16·1*
,, Straight ..	121	44·5	102	37·5	49	18·0
,, Deflected right ..	20	39·2	17	33·3	14	27·4*

* Difference not statistically significant.

When Tables 7 and 8 are considered, it is seen that the proportion of strikes which involved the left, right, or both sides of the crutch is approximately the same as the proportion of sheep which tended to be struck in these situations.

It would appear, therefore, that deflection of the vulva to either side did not tend to increase the incidence of strike in the sheep in which it occurred. Nevertheless, the percentage struck on the right side was nearly twice as high in sheep showing deflection of the vulva to the right as in those showing deflection of the vulva to the left. The number of sheep showing right-sided deflection of the vulva is, however, too small to permit any definite conclusion to be drawn, and on the figures available it has no statistical significance.

The main purpose of recording these observations on vulvar deflection is to point out that, while gross deflections, causing inevitable urine-staining of the crutch on one side or the other, would no doubt lead to repeated crutch strikes on that side, such deflections are not common. There was not one of them among the experimental or control sheep in this trial. The minor degrees of deflection, which are very common (see pl. 4, Fig. 2) evidently are not a serious factor in urine-staining of the breech wool.

2. Observations on Tail Strike.

During the progress of the trial at "Dungalear," we were impressed with the high incidence of tail strike, 11 per cent. of the treated sheep and 18 per cent. of the controls being struck on the tail. As very little information is available on the predisposing factors and incidence of tail strike, it was decided to examine these sheep in detail.

Mackerras (1936) states that 6 per cent. of the struck sheep at Canberra were struck on the tail only. Carter and Belschner (1937) found that 11 per cent. of the struck sheep in the groups they were observing were struck on the tail, the incidence being 4.6 per cent. for A class sheep, and 12.9 per cent. for C class sheep.

Seddon, Belschner, and Mulhearn (1931), refer to tail strikes probably starting in the dimple which forms on the stump when a very wrinkly tail is cut off short. Seddon (1935) states that tail strikes can largely be controlled by a modification of the tailing operation, as a dimple is liable to result when the skin on the dorsal side of the tail is cut unnecessarily high up in an endeavour to cover the stump with non wool-bearing skin.

In the latter part of 1937, Mr. Stephen, of "Dungalear," reported that a very high proportion of the tail strikes occurred in sheep which had virtually no tail left, as they had been docked so short as to leave only one free joint and, in some instances, none at all.

In February, 1938, Dr. Mackerras co-operated with us in re-classifying the breeches of the sheep to note the effect of the operation and also classified their tails into three classes, A, B, and C. This classification was based on size and extent of tail wrinkles, corresponding approximately to the degrees of wrinkliness of the A, B, and C breech classification. The tail classification did not attempt to predict susceptibility to tail strike, being only a convenient measure of tail "development."

In order to see whether there was an association between development and length of tail and tail strike, both the control and the treated sheep were grouped according to their tail length and tail classification and the disposition of tail strikes was determined.

The incidence of strike (see Table 9) shows a very close relationship between tail strike and short C class tails, there being a marked fall in the strike incidence if the tails are plainer or longer. The proportion of A, B, and C class tails is approximately the same for each length.

Table 9.—Length and Classification of Tails Involved in Tail Strike.

—	A Class Tails.			B Class Tails.			C Class Tails.		
	Number Sheep.	Number Sheep Tail Struck.	Percentage Sheep Struck.	Number Sheep.	Number Sheep Struck.	Percentage Sheep Struck.	Number Sheep.	Number Sheep Struck.	Percentage Sheep Struck.
Long Tail ..	1	..	..	15	..	..	46	3	6·5
Medium Tail	3	..	..	46	5	10·8	110	12	10.9
Short Tail ..	12	..	..	144	9	6·2	240	62	25·8

It can be seen from the graphs shown in No. 1 of this series (pp. 65, 66) that there was a comparatively long period of freedom from tail strikes after each crutching, and that this was not associated with the density of the fly population, as the peaks for tail strike often occurred when the incidence of crutch strike was falling off. Owing to the erratic manner in which sheep were struck on the tail, such strikes would often occur during periods of comparatively slight fly activity, and yet fail to recur during subsequent periods of intense activity. A high proportion of the sheep struck on the tail in December were not struck during the spring. This variation in the strike incidence and the comparative freedom from re-strikes on the tail made it impossible to select groups which were highly susceptible or otherwise to tail strikes. All sheep which had been struck on the tail were, therefore, examined.

In most cases the woolled skin from the dorsal side of the tail had been pulled down over the end of the tail stump and, in some cases, even on to the under side of the tail. The wool from such skin consequently grew towards the vulvar orifice (see Pl. 3, Fig. 2), and once it attained sufficient length it was inevitably soiled with urine.

It appears that the protection from tail strike subsequent to crutching represented the time required for the wool to grow to the requisite length for this to occur. It will be noticed that the periods of protection from tail strike after the July, 1937, and October, 1937, crutchings are approximately the same, while that after the February 1938 crutching is only a week or so longer.

Normally, when urinating, a sheep lifts its tail clear, but these sheep, having in many cases only one free joint or none at all, were unable to do so. In addition, when the tail was docked as short as

this in sheep with C class tails, the result was to allow the large tail folds to sag inwards from either side so as to meet each other in the space normally occupied by the tail stump. A deep cleft was thus formed over the end of the tail affording good cover and protection for the maggots. This cleft is well illustrated in the accompanying photographs (Pl. 3, Figs. 3 and 4).

We considered that, had the tails been left the length of the "long" tail group, and had they been cut to pull the non wool-bearing skin from the under side of the tail over the stump, there might have been a markedly lower incidence of tail strike in this flock. Owing to the scarcity of information or experimental data on the incidence and possible predisposing causes of tail strike, we can offer no other suggestions for its prevention. Further observations on "tailing" appear to be needed in this connexion.

3. The Correlation of Tail-fold and Crutch-fold Development.

A considerable divergence of opinion exists as to whether it would be possible to recognize treated sheep by their general conformation. This point is of importance, since one of the strongest criticisms levelled against the operation is that a buyer might not be able to distinguish between naturally A class sheep and treated sheep. Observations by different workers do not entirely clarify the position.

Seddon (1935) says "it is hard to detect operated ewes, and to outward appearance, as in the yard, a line of such sheep will appear plain crutched. . . . Buyers might easily and inadvertently acquire operated sheep in the belief that they were plain crutched."

Belschner and Hindmarsh (1937) state: "In our experimental flocks we have quite frequently been unable, in the groups submitted to both the modified and radical operation, to differentiate surgically treated from naturally A class sheep."

Mackerras (1935) adopts the opposite view and states that, if only the wrinkles that are liable to urine-scalding be removed, sheep men would not be misled, since the treated area is barely visible when the sheep is in the wool and all the other signs of a wrinkly type remain as clearly to be seen as in untreated sheep.

Mackerras (1937) suggested that the effects of Mules' operation could be assessed by the way in which it altered the conformation of the breech of treated sheep. In this connexion, Dr. Mackerras re-classified these sheep with us some six months after the operation. Each sheep was examined individually while it walked slowly along a classing race. The examination was made just after crutching. At the same time the tails of the sheep were classified according to the degree of development corresponding to the classes used for crutch wrinkles. It should be realized that the criterion for tail classification was "development" of tail wrinkles only, and the classification did not attempt to assess predisposition to tail strike.

In Table 10 below, the sheep of the control group have been classified according to their crutch wrinkles, and the classification of the tails for each class is also given.

On seeing this classification carried out, we noted that the "A", "A—", and "B+" groups of Mackerras were equivalent to our

original "A" class sheep, Mackerras' "B" was equivalent to our "B", and Mackerras' "B—" and "C" were equivalent to our "C" class.

It will be seen that, in this flock, there was a fairly close association between tail and breech development, the tail being, in general, more heavily developed than the breech. It is noticable that among 277 B, B—, and C class sheep, there were none with A, A—, or B+ tails.

Table 10.—Correlation of Crutch and Tail Classification.

Crutch Classification. Class.	Number Sheep.	Tail Classification. A	A—	B+	B	B—	C
A	21	3	..	..	17	..	..
A—	5	..	..	..	5	..	..
B+	18	1	..	..	16	1	..
B	145	..	..	..	49	64	32
B—	55	..	..	..	2	27	26
C	77	..	..	..	..	1	76

Owing to the absence of any published information on this point, we are unable to state whether the correlation between the extent of crutch and tail folds, which was so apparent in this flock, applies to Merino flocks as a general rule. It seems, however, that there would be sufficient indication of the degree of development in the tail and body of sheep, upon which Mules' operation had been performed (to an extent sufficient to give the degree of protection against breech strike of which it is capable), to enable graziers to eliminate the C class and the worst of the B class, which is the first step in breeding for insusceptibility to crutch strike. In our view, therefore, there is no reason why pastoralists should not avail themselves of the benefit conferred by this operation, while at the same time aiming at the elimination, by breeding out, of the most wrinkly and hence the most susceptible sheep.

4. Discussion.

It will be apparent from the data presented above that we were unable to find any evidence in support of the contention that distortion of the vulva, either through shortening or deflection of the tip, has the effect of increasing the incidence of crutch strike.

Since shortening and deflection of the vulva were alleged to result from "scabby ulcer," it follows from our results at "Dungalear" that if this condition was, in fact, responsible for the short and deflected vulvae there met, it is of little, if any, importance so far as crutch strike incidence is concerned.

From our own observations, however, it appeared that shortness of the vulvar tip was not necessarily due to any pathological change but that in very many instances it was the natural conformation.

Moreover, we were impressed by the number of cases we observed in which the tip or side of the vulva had been wounded by the machines during crutching. At out first examination, when a record of these injuries was made, it was found that 12.8 per cent. of the sheep had been wounded in this way during crutching on the previous day. In most cases about 2–4 millimetres of the tip had been cut off completely, or else was cut nearly through. We do not think such wounds would lead to any distortion or interference with the flow of urine, provided they healed cleanly, but a wound in such a position is very liable to infection, and in some cases, this may spread sufficiently to cause some distortion before it eventually subsides. In several cases of vulvar deflection, scar tissue could be seen which, by its position and extent, suggested a wound incurred during a previous crutching or shearing.

In passing, it may be mentioned that, in the few instances at "Dungalear" where an attempt was made to correct a deflected vulvar tip by excising a small segment of skin from the side of the vulva opposite to the deflection, subsequent examination, after some six months had elapsed, showed that it had been unsuccessful.

While experiments are desirable to determine the most suitable manner in which lambs should be docked, it will be seen from the above records that our observations did not support the contention that the tail should be cut short (i.e., on a level above the upper limit of the vulvar orifice). The objections to such a practice are that: (i) in the case of wrinkly-tailed sheep the central tail folds, being no longer held apart by the tail itself, come together and a cleft, which may well become attractive to blowflies, is formed between them; (ii) the wool from about the stump of the tail, as it lengthens, tends to come in contact with the vulvar orifice and to be wetted with urine. These two points are exemplified in the accompanying photographs (Plate 3).

If the tail is cut so that the stump is slightly below the lower limit of the vulva, only the non-wool-bearing skin of its under surface can come in contact with the vulvar orifice, and the tail, being longer, can with greater ease be lifted clear during the act of urination. The objection which was advanced against docking at this length was that the long stail stump caused deflection of the vulva, with consequent urine-staining of the crutch, but the observations on this point recorded above do not support that contention. We therefore consider that this objection no longer holds. It appears to us that the orthodox, but ill-observed, practice of cutting the tail so that the bare skin from the under surface covers the stump when healing is complete, has much to commend it.

As regards the data concerning tail and breech classification, it will be observed that, while the usual classification covers three types, A, B, and C, these classes are further subdivided in Table 10 to make six in all. Such fine distinctions have a definite value in experimental work of this sort, even though the personal factor must necessarily enter into it, and probably no two observers would group a large number of sheep in exactly the same way. Nevertheless, it seems

desirable to point out here that, for practical application, when the sole consideration is the removal of certain crutch folds to reduce susceptibility to fly strike, only two classes need be considered—those which require the operation and those which do not.

From this and the preceding study, certain points have emerged which establish clearly the value and importance of the operation. It has been shown, (i) that it was necessary to remove only those few crutch folds which are prone to urine-staining in order to reduce the incidence of crutch strike to a remarkable degree; and (ii) that sheep so treated, if originally of an undesirable wrinkly type, were not disguised by the operation. We therefore consider that, if rightly applied, the use of Mules' operation need not conflict with a policy of breeding away from a wrinkly type of Merino. We regard these two practices as complementary to each other, not as alternatives. The advantages of the operation may well be enjoyed while the breeding policy is being put into effect, and used subsequently, as required, to supplement the benefits to be derived from such a policy.

5. Conclusions.

1. The length at which the tail was docked was not a factor in causing deflection of the vulva in the flock concerned.

2. Although sheep were more commonly struck on the left side of the crutch than on the right, and the vulva is more commonly deflected to the left than to the right, these two facts seemed to be unrelated. Our observations concerned the minor degrees of vulvar deflection that are commonly encountered. No case of gross deflection or distortion of the vulva was observed.

3. Crutch strike was commoner among sheep docked short than among those with longer tails. This was not related to "development" of the breech, and no obvious explanation can at present be given for it.

4. Tail strikes were associated with shortness and wrinkliness of the tail. The possible reasons for this are discussed.

5. "Scabby ulcer" of the vulva, if it is a factor in causing erosion of the tip of the vulva, and thus leading to unilateral urine-staining and fly strike, was not operative at "Dungalear."

6. There was a very close correlation between crutch fold and tail fold development among these sheep, the general tendency being for the tail to show somewhat more "development" than the crutch.

7. We are of the opinion that further observations should be made regarding the technique of docking that is best designed to prevent urine-staining of the tail wool, or the formation of clefts and dimples in the tail stump which, for one reason or another, become attractive to the fly.

8. In the light of our observations, we see no reason why the Mules operation of fold removal should not be utilized for the reduction of crutch strike in Merino flocks concurrently with a breeding policy designed to eliminate the more wrinkly-breeched sheep.

6. Acknowledgments.

Our sincere thanks are due to Mr. John Campbell for permission to conduct this trial at "Dungalear," to the manager, Mr. Makeig, and his staff for their ever willing and helpful co-operation, and especially to Mr. J. C. Stephen, whose careful supervision of the sheep and records of strikes, have played an essential part in the successful conduct of the trial.

To Dr. J. H. Riches, of the National Field Station, "Gilruth Plains," Cunnamulla, we are indebted for his assistance when the sheep were first classified, and to Dr. I. M. Mackerras, of the Division of Economic Entomology, Canberra, for his co-operation in checking the breech classifications subsequently.

Mr. J. H. W. Mules, of Adelaide, has our grateful acknowledgment of his willing co-operation and assistance when the trial was initiated. He carried out nearly all the operative procedure personally. Lastly, we should like to thank the several members of the staff of this Laboratory who have offered various helpful suggestions and criticisms from time to time, particularly Mr. H. B. Carter, who kindly took some of the photographs for us. Finally, the whole investigation was made possible by the financial support of the Australian Wool Board.

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A Colour Method of Detecting the Depth of Penetration of Sodium Chloride into Timber which has been Immersed in a Solution of the Salt.

*By G. W. Wright, B.E.**

Summary.

In order to determine the depth of penetration and rate of diffusion of sodium chloride into timber which has been immersed in a solution of that salt, a technique which comprises spraying a freshly cut section of the timber with a silver nitrate solution, and then exposing the sprayed face to sunlight has been developed. A strong colour contrast between the silver chloride precipitate which is formed in the area affected by the diffusion of sodium chloride, and the darkened deposition of silver in the area not affected by the sodium chloride is obtained, and it clearly indicates the line of demarcation between treated and untreated zones.

1. Introduction.

With the development of "chemical seasoning" during recent years, a very considerable advance in the technique of drying refractory timbers and specialty and large dimension stock has been made.

"Chemical seasoning" consists essentially of first immersing the timber to be dried in an aqueous solution of a hygroscopic material, the length of immersion and the temperature of the solution being controlled primarily by the species, thickness, and moisture content of the stock being treated. At the conclusion of the bath treatment, the timber may be either kiln- or air-dried in the normal way, the particular virtue lent by the period of initial immersion in solution being that, during the subsequent seasoning, the timber may be subjected, with perfect safety, to drying conditions which would prove much too severe for untreated stock.

The success of the process is dependent almost entirely on a penetration of the hygroscopic material used into the timber for distances up to ½ inch or so. As an insufficiently deep penetration, or an excessive penetration, are equally undesirable, it is obvious that some method of qualitatively detecting the depth of penetration is necessary, so that the length of treatment may be determined.

Among other materials, sodium chloride, invert sugar, urea, and calcium chloride have all proved satisfactory as solutes. Sodium chloride is probably obtainable at a lower cost than any other of the materials which may be used, and accordingly is being employed extensively in experimental work on this project.

2. Method of Detection.

The test for a chloride by interaction with silver nitrate is well known. This test appeared the obvious method for use in detecting the presence of sodium chloride in timber in which penetration of the salt had occurred, but early attempts at qualitative detection by this means did not prove particularly satisfactory. Difficulty was found

* An officer of the Division of Forest Products.

in preventing "running" of the silver chloride when formed and in determining its outline, with the result that the actual depth of penetration could not be definitely determined.

Ultimately, the technique discussed as under was developed, and it is now being used with success.

Having obtained the surface of the sample in a reasonably dry condition (in the case of wet sections, by placing them in an oven for a few minutes) all traces of free or unabsorbed salt are removed from exposed surface faces. A section, say, $\frac{3}{8}$-inch in length in the direction of the wood fibres, is then sawn from the sample or original section, a fine-toothed band-saw being used. A considerable number of repeat tests have indicated that any "carry-over" of salt is negligible.

One complete face (end grain) of the section is then sprayed thoroughly with a 10 per cent. solution of silver nitrate, a very fine spray*, which permits the application of the nitrate to be made without the formation of small droplets, being used. The sample is then exposed to sunlight for a few minutes, at the conclusion of which the areas in which diffusion has taken place contrast strongly in colour with the areas in which no diffusion of the salt has occurred. The area of diffusion appears much lighter in colour than the normal wood of the species owing to the presence of the white silver chloride precipitate. On the other hand, the areas in which no diffusion of sodium chloride has occurred appear much darker in colour than untreated wood owing to the deposition and darkening of the silver radical in the presence of light.

Plate 4, Figs. 1 and 2 show the pronounced colour contrast obtained. The former illustrates the penetration which was obtained in a sample of *Sideroxylon pohlmanianum* (yellow boxwood—a pale-coloured wood) during immersion in a saturated solution of sodium chloride for eleven days at atmospheric temperature. In Pl. 4, Fig. 2, is shown the penetration obtained in a sample of *Eucalyptus marginata* (jarrah —a dark coloured wood) after immersion in a similar solution for fourteen days. The effect of the presence of gum veins in facilitating diffusion is clearly shown, as is that of a pocket of included sapwood near the centre of the sample.

* It is important that a metal spray be not used; otherwise the silver radical may be displaced from the silver nitrate as this passes through the metal nozzle. A spray made of glass is being used with success.

PLATE 1.

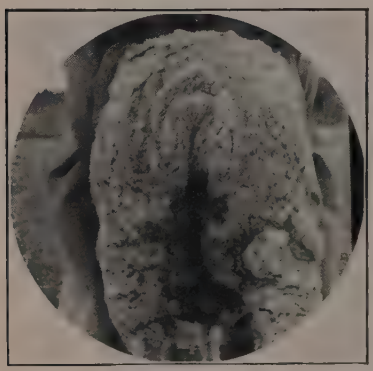
The "Blinker" Electrical Moisture Meter: Recent Modifications. (See page 13.)

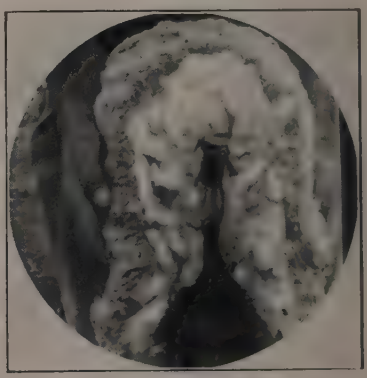
FIG. 1 (top).
FIG. 2 (bottom)

Studies on Fly Strike in Merino Sheep. No. 1.—The Effect of Mules Operation on the Incidence of "Crutch" Strike in Ewes. (See page 53.)

FIG. 1.—C Class untreated sheep showing marked urine staining.

FIG. 2.—Sheep similar to No. 1 but treated 6 months previously. Note relatively small area of crutch involved in the operation and the wrinkles still remaining about tail and side of crutch.





FIGS. 3 (left) and 4 (right).—The same sheep taken before and after crutching. They show clearly how the presence of wool on the crutch hides the crutch folds.

Studies on Fly Strike in Merino Sheep. No. 2.—Miscellaneous Observations at "Dungalear" on the Influence of Conformation of the Tail and Vulva in Relation to "Crutch" Strike. (See page 71.)

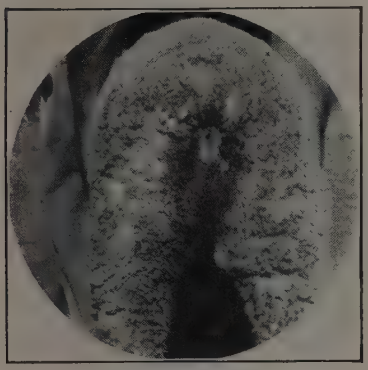


FIG. 1.—Urine staining of wool on tail stump resulting from docking too short. The wool is touching the vulvar orfice.

FIG. 2.—Vulva deflected to right. This degree of deflection was quite common but did not lead to urine staining of the crutch.

FIGS. 3 (left) and 4 (right).—Cleft formed between tail folds as a result of docking too short.

PLATE 4.

A Colour Method of Detecting the Depth of Penetration of Sodium Chloride into Timber which has been Immersed in a Solution of the Salt. (See page 83.)

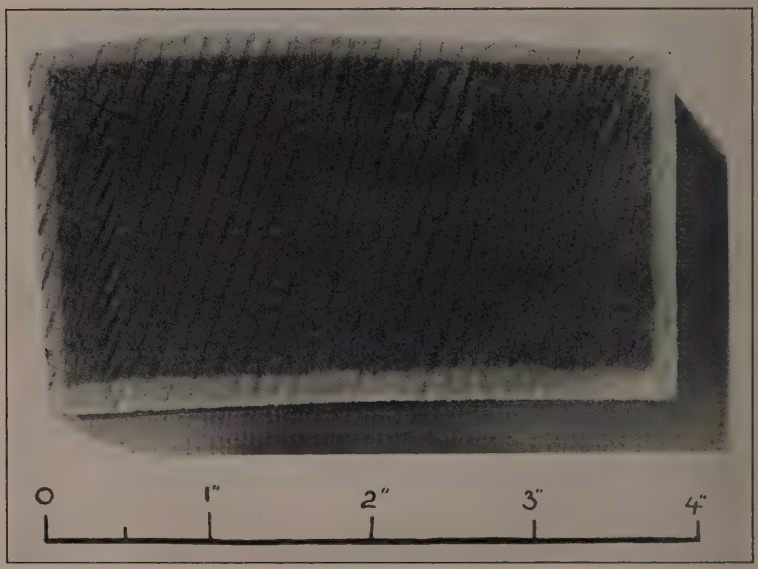


FIG. 1.—A sample of *Sideroxylon pohlmanianum* (yellow boxwood) showing depth of penetration of sodium chloride.

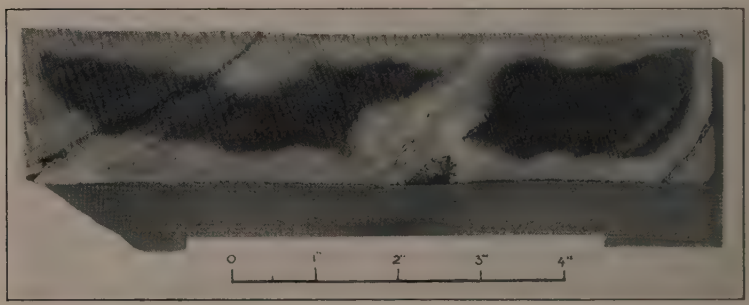


FIG. 2.— A sample of *Eucalyptus marginata* (jarrah) showing depth of penetration of sodium chloride. The effect of the presence of gum veins and an area of included sapwood is clearly seen.

NOTES.

The Control of Silverfish.

(Contributed by the Division of Economic Entomology.)

A note on the control of silverfish appeared in the November, 1936, issue of this Journal. The method recommended was to distribute bait cards after thoroughly spraying the infested premises with a pyrethrum-kerosene insect spray. Since the publication of that note, experiments have shown that an increased concentration of the poison used—barium fluosilicate—did not affect the attractiveness of the baits; and as silverfish appear to consume very small quantities of food, an increase in the toxicity of the baits would clearly be advantageous.

Baits are most easily prepared by spreading the poisoned paste with a paint brush on large sheets of thin cardboard (sheets, approximately 2 feet by 2 ft. 6 in., can be obtained for a few pence at most stationers). The card should be painted on both sides, and when dry, should be cut into small pieces—2 inches by 3 inches is a convenient size.

To make the poisoned paste, mix 4 oz. flour and 6 oz. sugar in 40 fluid oz. (1 quart) of warm water; then add and stir in 5 oz. barium fluosilicate. Paste sufficient for the baits required for an ordinary house can be prepared by using one-quarter of the above quantities. Barium fluosilicate of commercial grade, quite suitable for use in silverfish baits, can be obtained under the proprietary name of "Dutox" from Messrs. A.C.F. and Shirley's Fertilizers Ltd., Little Roma Street, Brisbane. Other chemical suppliers may also now be stocking the material.

In an average-sized room, between ten and twenty baits should be set out in places where silverfish are most likely to be found; e.g., in the wall skirtings, behind furniture and pictures, in drawers and cupboards, and behind books on shelves. The baits should be left undisturbed, and should be kept out of reach of children.

Effective control of bad silverfish infestations has been obtained in several Canberra houses by means of bait cards alone, but, as a general rule, a thorough preliminary spraying is necessary to reduce the initial population of the insects. Any of the well-known fly-sprays can be used. To be effective, spraying should be done after dark, and the later the better. When the rooms have been in darkness for several hours, a large proportion of the insects will have left their daytime hiding places, and can be found moving over the walls, &c. If a house is treated systematically, room by room, the spray being forced into all cracks and crevices, a heavy infestation can be reduced to negligible proportions in a very short time.

Rooms in which large quantities of books, periodicals, or loose papers are stored present a special problem. Because of the superabundance of food available to the insects and the multiplicity of sheltering places, neither the distribution of bait cards nor hand spraying is likely to be effective when such premises become badly infested with silverfish. By using a power-driven paint spray-gun, however, satisfactory control can be obtained. To secure the best possible results with a power spray, two men should work together, one operating the gun and the other shifting the stacks and disturbing the papers so as to permit the spray

to penetrate into the places where the silverfish are lurking. A sufficient length of tubing between the gun and the pressure cylinder should be provided to give the operator freedom of movement.

A certain number of silverfish will always survive even the most thorough spray treatment (the chief purpose of distributing baits is to destroy these survivors and their progeny); so, when spraying alone is depended on, treatment must be repeated at intervals as the circumstances demand.

While bait cards or spraying, or a combination of the two, can be employed to reduce silverfish infestations, in many cases it will be desirable also to protect articles from attack. Miss E. A. Lindsay, of the School of Agriculture, University of Melbourne, has recommended the use of tricresylphosphate for this purpose. A 1 to 2 per cent. solution of this substance in "white spirits" (refined kerosene) may be applied to papers, &c., with a brush or spray. According to the same authority, a saturated aqueous solution of tartar emetic is also very effective, and can be used on articles which would not be affected by water.

Chemistry Research Board of Great Britain—Report.

Copies of the report of the Chemistry Research Board of Great Britain for the triennial period ending 31st December, 1937, have recently become available in Australia.

The Board is one of the organizations which operates under the British Department of Scientific and Industrial Research, and it is provided with central laboratories close to the National Physical Laboratory, Teddington; it employs some 80 people on its staff, and its annual vote is in the region of £21,000.

One or two extracts from the Board's recent report appear below:—

"An investigation into the fundamental causes of the corrosion of metals has been continued under the supervision of our Corrosion of Metals Research Committee. These experiments, conducted under carefully controlled conditions capable of giving reproducible results, are necessarily of a long range character. Concurrently with this enquiry into the basic causes of corrosion, problems of immediate industrial interest, such as the corrosion of locomotive boiler tubes, fire extinguishers, and an industrial water supply system, have been investigated in co-operation with the organizations and firms concerned; a new method of producing an artificial green patina on copper has also been devised."

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"In the somewhat less familiar field of industrial microbiology, problems have been examined on such diverse topics as the preservation of ropes and cordage against microbiological decay, the discoloration of paintwork, the origin of an unpleasant bacterial odour in beer, and the destruction of micro-organisms in food by the action of gases under pressure. A study of various types of sulphur bacteria leads to the belief that one group, which reduces sulphates, is in certain circumstances responsible for the corrosion of petrol storage tanks and water mains. In the case of cast-iron mains, the pipes are attacked until the affected area is increasingly denuded of iron and is reduced

to a soft matrix consisting mainly of graphite. In this study, field work has been confirmed by controlled laboratory experiments, in which processes occurring in the soil are reproduced."

. . . . . .

"In the first report reference was made to the Laboratory's useful function in supplying chemical talent for the benefit of industry. This attribute has been intensified in the period under review which coincides with the revival of trade. In this respect the Laboratory may be regarded as a noteworthy indicator of the prosperity of chemical industry. During the last three years some twenty members of the staff in various grades have resigned to take up responsible positions in industrial organizations dealing with different branches of chemical manufacture. It is significant that half of these resignations have come from members of the group working on synthetic resins, a section of the Laboratory which is in close contact with the latest developments of a rapidly growing branch of chemical technology."

. . . . . .

"For facility of administration and control, the scientific work of the Laboratory is conducted in ten separate sections which deal with specific items of the research programme; some of these are long range problems in pure chemistry, whereas others have an immediate practical objective. It is, however, undesirable to draw a hard and fast distinction between these contrasted types of scientific enquiry, and the aim of this Laboratory has hitherto been to encourage a judicious blend of the two."

"The more detailed account of the researches of the various sections which now follows may serve to show why the Laboratory is becoming recognized increasingly as a storehouse of chemical information for those branches of the science which are included within the scope of its research programme."

The following are examples of results of immediate or potential importance which have been obtained:—

1. In fundamental studies on the formation of oxide films on iron during the initial stages of exposure, interesting co-ordination between rates of film formation and temperature has been made. Various formulae, both rational and empirical, have been obtained. The existence of a critical temperature of 200°C. has been noted, and changes in the lattice structure of the film above and below the critical temperature have been investigated.

2. The inter-dependance of traces of atmospheric impurities in their effect on corrosion of metals has been studied. Of particular interest is the effect of small particles of carbon in increasing the corrosive action of traces of SO_2 which has been noted and has been shown to depend on local concentration of SO_2 by adsorption on the carbon particles. It has also been shown that, contrary to the generally accepted view, CO_2 may sometimes exert a repressive effect on corrosive reactions.

3. Studies of the mechanism of corrosion in boiler tubes are in progress. Preliminary results indicate that the mechanism of corrosion by magnesium salts is not precisely in accord with the hypothesis at present very generally accepted by engineers that is is to be explained simply by the liberation of acid by hydrolysis.

4. The growing importance of magnesium and magnesium alloys as light materials for aircraft construction has led to intensive study directed to the discovering of means of reducing surface corrosion, which is one of the chief disadvantages of these materials. Considerable success has been obtained with thin films of selenium produced by immersing for 5 to 10 minutes in solutions of selenious acids.

5. Encouraging results have been obtained with the method of hydrogenating coal suspended in a colloidal state in oil. This work is directed to the possibility of developing hydrogenation equipment of a tubular form, in order to simplify construction to withstand the high pressures involved.

6. In the field of chemotherapy, one of the new arsenicals developed, succinanilomethylamide ("neocryl") has now reached the stage of clinical investigation, and preliminary results in the treatment of syphilis and sleeping sickness indicate that its activity is equal to that of the generally used tryparsamide, but it is definitely less toxic.

Other investigations of the Board concern high pressure research (acetic acid synthesis), higher aliphatic acids (synthesis), coal tar and rubber, chemotherapy, synthetic resins, water pollution, microbiology (including the preservation of ropes, paints, &c.), road tar, researches on the rarer metals (rhenium, germanium, gallium, &c.), and certain chemical engineering problems.

Glass Research in Great Britain—New Laboratories.

The important repercussions in industry of the results of pure scientific research were developed by Sir William Bragg as the main theme of his address when he opened the new research laboratories attached to the glassworks of Messrs. Pilkington Brothers Limited, at St. Helens, England, recently. The methods of X-ray analysis evolved during investigations to elucidate the internal structure of crystals have enabled rapid progress to be made in the production of new materials with a variety of properties.

The remarkable net-like structure of glass revealed in this way has laid the foundation for a wholly new attempt to relate the physical and other properties of glass with its chemical constitution. This fuller understanding of the constitution of glass has led to further control over manufacturing methods, and finally to the production of glasses with remarkable new properties.

Together with the equipment, the cost of the laboratories is about £40,000, and they are designed to house the Director of Research and a staff of 47, including 15 to 20 University graduates, and about 25 technical assistants. A novel feature is the use of glass bricks for the internal corridor walls. Most of the physical laboratories are devoted to special instruments or special testing processes, they include an X-ray laboratory with a fully automatic X-ray apparatus for the identification of crystals and the determination of the viscosity of glass. The main block of the research laboratories includes a large analytical laboratory and laboratories for general chemical research and organic research.

The new research department is intended to function in the more academic field of science, and will, it is expected, frequently be

responsible for fundamental work on first principles. The problems with which the new laboratories will be confronted fall into seven categories, covering the melting of glass, the study of refractories, the processing of glass, uses of glass, the properties of glass, methods of testing glass, and simultaneous matters such as the production of mirrors to withstand rigorous weathering and temperature conditions.

The Imperial Bureau of Dairy Science.

In 1936 the British Commonwealth Scientific Conference which met in London to consider the working of the organizations controlled by the Executive Council of the Imperial Agricultural Bureaux, recommended that a new Imperial Bureau of Dairy Science be established. The conference also suggested the National Institute for Research in Dairying as the most suitable location for the Bureau.

Following agreement by all the authorities concerned, the new Imperial Bureau of Dairy Science has now been established at Shinfield, near Reading. Prof. H. D. Kay, O.B.E., Ph.D., D.Sc., Director of the National Institute for Research in Dairying, has been appointed Director of the Bureau. Mr. W. G. Sutton, M.Sc., A.I.C., from Massey Agricultural College, New Zealand, has been appointed Deputy Director and has now taken up his duties. The Bureau is financed co-operatively by the Governments of the British Empire in the same way as the other Imperial Agricultural Bureaux.

The functions of the Bureau are to index research work in dairy science, whether carried out in the Empire or elsewhere, to collect, abstract, and collate information bearing on dairy science, and to distribute such information both by publication and by private communication to research workers, officials, and advisory officers throughout the Empire. In addition, the Bureau is charged with the duty of establishing and maintaining contact between research workers with common interests, promoting conferences of workers and visits to research centres, and in general encouraging the circulation of information, ideas, material, and personnel.

The field of dairy science to be covered by the Bureau was defined by the Conference when recommending its establishment. This field includes the microbiology, chemistry, and physics of milk and its products; animal diseases in so far as they affect milk and its products; the technology of processing milk and manufacturing dairy products; the physiology of milk secretion as affecting quality and quantity of milk and dairy products; standards for the composition and quality of milk and its products.

The routine duties of the Bureau, such as indexing and abstracting, will already be familiar to many dairy workers from the activities of the Bureaux already established in other subjects. An aspect of Bureau work which may not be so well known and understood is the more informal service which can be given to research workers, teachers, and field officers. The Bureau aims to be the friend of these dairy workers. The Bureau will deal directly with the individual workers in dairy science, who are invited to write to the Bureau for information which is not obtainable in their own countries. The Bureau may be able to supply the information itself, or to put the inquirer in touch with someone who can do so more effectively.

The new Imperial Bureau of Dairy Science has been established in answer to requests for a clearing house for information in dairy science; its value to dairy science, and to the dairy industry generally will largely depend on the extent to which research workers and others avail themselves of its services.

The Deterioration of Butter in Cold Storage.*

Oxidation of the fat is one of the most serious causes of deterioration in butter submitted to long periods in cold storage. Salted butter which is made from ripened cream is known to be particularly susceptible to this deterioration. It has generally been assumed that the acidity developed in the ripening process is responsible for the fact that the oxidation is more rapid than in butter made from sweet or neutralized cream. Some experiments previously reported (this *Journal* **10**: 327, 1937), showed that the fat of unsalted butters made from ripened cream oxidized much more rapidly in cold storage than the fat of butters made from cream acidified with lactic acid, indicating that the starter organisms, or some product other than lactic acid, was largely responsible for the rapid oxidation.

Further experiments with both unsalted and salted butters have been made. It has been found that acidity (due to additions of lactic acid to the cream), salt, starter organisms, and a lowering of the pasteurization temperature, all separately favour the oxidation. Neither diacetyl nor acetoin influence the oxidation. The results indicate the presence in pasteurized, ripened cream and in unripened, raw, or low-temperature, pasteurized cream of a fat-oxidizing enzyme which is most active at low pH values (about 5) and high salt concentrations. A full account of the work will be published shortly in the *Journal of Dairy Research*.

Reviews.

"Principles of Modern Building", Vol. 1, Walls, Partitions and Chimneys, by R. Fitzmaurice, B.Sc., Assoc. M.Inst.C.E., Building Research Station, Department of Scientific and Industrial Research. (Pp. 400. London. H.M. Stationery Office, 1938. Price 10s. 6d.)

During the last few years, several very excellent reference books have been published for the purpose of assisting the architect or builder to work out the multitudinous problems and details with which he is confronted. This new book by Fitzmaurice must be added to the already large number of volumes which should be in every architectural office. The subject matter is presented in a form which has become a feature of the many articles and bulletins issued by the Building Research Station of the British Department of Scientific and Industrial Research. It summarizes, in a connected manner, the knowledge gained from seventeen years' experience, supplemented by the wide experience of practical building problems resulting from answering the many thousand inquiries addressed to the Station by all branches of the industry.

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* A brief note prepared by Dr. W. J. Wiley, an officer of the Council who is accommodated at the Dairy Research Institute, Palmerston North, New Zealand, and relating to some work the results of which will be published in full later.

The preface is written by Dr. R. E. Stradling, C.B., M.C., D.Sc., Ph.D., M.Inst.C.E., Director of Building Research, who points out that the most important service that the Station could render, in bringing together its information and experience, would first be to provide as clear a formulation as possible of the functions of a building and of the elements of structure of which it is composed. A clear conception of fundamental principles is also important in adapting the use of new materials to the functions of a building.

Consequently, the architect or builder will not find in this volume a mere recapitulation of recommended methods and practices; neither will the young student find a text book describing the ordinary details of building construction. Still less has any attempt been made to teach the architect or builder what he already knows in that respect.

The subject of "Walls, Partitions, and Chimneys" has been discussed in nine chapters under the headings of the functions of the wall, solid load-bearing walls, load-bearing cavity walls, non-load-bearing members, monolithic reinforced concrete, surface finishes for external walls, special structural features, damp walls, and mortars.

In the present volume, answers will be found to such questions as—How much sound and heat insulation is necessary under given circumstances? When must thermal expansion be taken into account? What factors determine the formation of shrinkage cracks, and how can they be controlled?

The author has given a critical analysis of various methods of construction and examples are worked out showing how the various scientific data tabulated in the volume can be applied. Furthermore, the precautions to be taken in the choice and construction of various types of materials are indicated as a guide to the preparation of specifications.

It is intended that this volume should be followed by others which it is hoped will appear at intervals of about a year. Subjects to be discussed will include floors, roofs, structural framework, foundations, interior finishes, and decoration.

The formidable task of preparing this series of publications has been undertaken at the joint request of the Royal Institute of British Architects and the Chartered Surveyors Institute. All parties concerned are to be congratulated, for in Volume 1, "Walls, Partitions and Chimneys" the Building Research Station has made an invaluable contribution to the architectural profession. It is hoped that every architect and builder will not only read this book, but that it will find a permanent place amongst his few really good reference books.

W. R. Ferguson.

"Statistical Tables for Biological, Agricultural, and Medical Research," by R. A. Fisher, Sc.D., F.R.S., and F. Yates, M.A.

(Pp. viii + 90. First edition, Edinburgh: Oliver & Boyd, 1938. Price 12s. 6d.)

The authors of this book are already well known to most biological research workers, through their many excellent publications, and this volume will be very useful to anyone concerned with the statistical aspect of biological research. It is mainly a collection of tables that

have appeared separately in scientific journals or other publications by the authors, and the introduction gives a good summary, with examples, of a variety of statistical processes.

All the tables necessary for the ordinary significance tests, which are given in "Statistical Methods for Research Workers," are included. Some of them have been extended to cover smaller probabilities and more degrees of freedom, and a table of the ratio of variances known as F in Snedecor's notation has been added; the use of this quantity instead of Z simplifies the significance test in the analysis of variance.

A table of ordinates of the normal curve at intervals of 0.001 of the deviate from the mean is given, and a table also of probits corresponding to percentage frequency, the probit being equal to the normal deviate plus 5. The latter is of special use in the treatment of dosage mortality data, and this application is explained in the introduction.

A table for testing independence accurately in 2 x 2 contingency tables is included, and tables for transforming percentages and fractions to degrees, these being of value in analysing toxological data and sometimes in the analysis of variance of skew data. There are notes on the use of transformations in the introduction to the book.

Sections of particular value in planning factorial experiments are the Latin squares of sizes from 4 x 4 to 8 x 8, the complete sets of orthogonal Latin squares, combinatorial solutions for balanced incomplete blocks, and an index of possible arrangements with different numbers of varieties, blocks, and replications.

Common and natural logarithms, squares, square roots, and reciprocals are included, also factorials of numbers from 1 to 300 with their logarithms, natural sines, and tangents, $(90°-x)\tan x$, and a set of random numbers. The book concludes with a table of constant weight and measures, and some mathematical physical and chemical constants.

Differences and proportional parts are given in many of the tables, so that intermediate values can be read off rapidly, and appropriate methods of interpolation are indicated in the introduction.

The book is a convenient size to handle, and the tables are well set out in a good clear type, which makes them particularly easy to read. It is a book which could with advantage be included in any biometrical library.

F. E. Allan.

Winter School in Soil Science at the Waite Institute.

Following on a suggestion which originated in one of the State Departments, arrangements are being made for a Winter School for Soil Workers to be held at the Waite Agricultural Research Institute during the month of August, 1939. The School will be held under the auspices of the University of Adelaide and of the Council for Scientific and Industrial Research, and it will occupy not less than ten days beginning from 14th August.

It is not proposed to charge any fees, but all those attending must be accredited by their respective State Departments, Universities, or organizations.

It is considered that the School would be of value to soil workers, not only in that personal contacts would be made and ideas interchanged, but that methods and procedures of established value could be brought to the notice of every one. These ends will be served by a series of lectures and demonstrations following a definite plan, rather than by a conference at which disconnected papers would be read.

The lecturers and demonstrators will include Professor J. A. Prescott, Mr. C. S. Piper, Dr. A. Walkley, Mr. T. J. Marshall, Mr. C. G. Stephens, Mr. R. J. Best, Mr. T. H. Strong, Mr. J. S. Hosking, and Mr. A. C. Oertel.

In most cases, an introductory lecture will be followed by a practical demonstration. The following subjects have been tentatively chosen as likely to be of general interest:—

> Climatology and soil classification, soil survey, texture, structure, colour and water relationships of soils; minor elements in relation to plant growth; methods for the determination of trace elements, including chemical, spectrographic, and polarographic methods; soil acidity and lime requirement, including use of the glass electrode; the conductivity method for the determination of soluble salts and the electrometric method for the determination of soluble chlorides; wet and dry combustion methods for the determination of soil carbon; and soil—rhizobium relations.

A one-day excursion through the country near Adelaide, with examination of several soil profiles, will be arranged.

Representatives of State Departments interested have already been nominated in several cases, but other soil workers from the Universities or other organizations would be welcome.

Dr. A. Walkley, of the Waite Institute, has been appointed secretary to the School, and he will be pleased to answer any enquiries or to receive any suggestions which would make the school as useful as possible to intending visitors. His postal address is care of The Waite Institute, Private Mail Bag, G.P.O., Adelaide.

Recent Publications of the Council.

Since the last issue of this *Journal,* the following publications of the Council have been issued:—

Bulletin No. 122.—"The Establishment of Pastures on Deep Sands in the Upper South-east of South Australia." 1. The Origin and Scope of the Investigations, by H. C. Trumble, D.Sc., M.Agr.Sc. 2. The Influence of Cover Crops and Fertilizer Treatment on the Establishment of Selected Herbage Species, by C. M. Donald, B.Sc.Agr., and C. A. Neal Smith, B.Agr.Sc. With an Appendix on the Role of Seed Inoculation, by T. H. Strong, M.Sc.Agr.

The Bulletin discusses work which forms part of a co-operative programme of investigations in which the Waite Agricultural Research Institute of the University of Adelaide, the Carnegie Corporation of New York, and the Council for Scientific and Industrial Research co-operated. It is suggested in the publication that the development of the mallee-heath areas of the upper south-east of South Australia may best be attained by the inclusion of suitable herbage species, such as lucerne, subterranean clover, and Wimmera rye-grass, with the first, second, or third cereal crop, depending on the local conditions of soil fertility and the effectiveness of the initial clearing.

Bulletin No. 123.—"A Soil Survey of the Merbein Irrigation District, Victoria," by F. Penman, M.Sc., J. K. Taylor, B.A., M.Sc., P. D. Hooper, and T. J. Marshall, M.Agr.Sc.

The work discussed in this publication concerned the soil survey of an area of some 8,200 acres of Mallee land devoted chiefly to the production of dried vine fruits. General conditions in the area are described with special reference to climate, topography, and natural vegetation. A coloured soil map shows the distribution of sixteen soil types over the settlement. Occurrences of these types show the usual relations between elevation and texture, the lighter types occupying the higher land, with sequences through intermediate types to the heavier soils at lower levels. The topographic conditions are such that relations of this kind connote complex soil type aggregations and considerable difficulty in avoiding development of excess soil water and salinity problems on the slopes. Principles of subsoil drainage are therefore discussed in detail, together with the relations of soil salinity to crop production.

The work was carried out by the Council's Division of Soils in co-operation with the Victorian Department of Agriculture, of which organization one of the authors, Mr. Penman, is an officer.

Bulletin No. 124.—"The Wood Anatomy of some Australian Meliaceae with Methods for their Identification." (Division of Forest Products—Technical Paper No. 31), by H. E. Dadswell, M.Sc., and Dorothie J. Ellis, B.Sc.

This publication is a continuation of the series concerning examinations of Australian timbers for which the Division of Forest Products has been responsible. The particular woods discussed comprise the mahogany family which supplies a large variety of commercial, cabinet, and furniture timbers. A key to the identification of the Australian species is included. Reference has also been made to published information on the woods of the family, and a summary of anatomical characteristics has been included.

Pamphlet No. 85.—"A Chemical Study of some Australian Fish," by W. G. Jowett, M.Sc., and W. Davies, D.Sc., D.Ph.

The work discussed in this publication was carried out in the Chemistry Department of the University of Melbourne. That Department kindly undertook to accommodate the initial part of the chemical side of the investigations of the Council's Fisheries Section prior to the establishment of the Section's laboratories. The Pamphlet discusses the seasonal variation in chemical composition of barracouta, Australian salmon, and sea mullet, with a view to the suitability of these species, should supplies warrant, for reduction to fishmeal and oil. It was

found that the vitamin A contents of Australian fish liver oils are definitely higher than those of most common northern hemisphere fish. Another striking fact which emerged from the investigations is the great variation and composition of fish of the same species and same batch.

Pamphlet No. 86.—"A Study of the Pulping Properties of Three Trees of *E. sieberiana* using the Sulphate Process." (Division of Forest Products—Technical Paper No. 29), by J. C. Cavanagh, B.Sc., H. E. Dadswell, M.Sc., A. W. Mackney, M.Sc., and T. M. Reynolds, M.Sc., D. Phil.

Three trees of *E. sieberiana* (silver-top ash), which is found in favorable quantity and size in the southern coastal districts of New South Wales, have been investigated. The object was to study the variability in the yield and the quality of the pulp that could be expected from different parts of the one tree and from different trees. The investigations were rendered possible as the result of co-operation afforded by the paper industry to the Council's Division of Forest Products.

Pamphlet No. 87.—"The Mechanical Properties of South Australian Plantation-grown *Pinus radiata* (D. Don)." (Division of Forest Products—Technical Paper No. 30), by Ian Langlands, B.E.E.

In view of the extent to which *Pinus radiata* timber is being grown in Australia and New Zealand, a knowledge of its strength and other properties is of importance to Australian industry. The Division of Forest Products has accordingly carried out a series of tests on the mechanical properties of the timber; the results are published in this Pamphlet.

A considerable variation in properties according to the position in the tree was found, the sapwood near the butt usually being the strongest portion. The Pamphlet contains a description of the influence on rates of growth on the properties of the timber, and also gives a table of permissible working stresses.

Pamphlet No. 88.—"The Oriental Peach Moth (*Cydia molesta* Busck.). Investigations in the Goulburn Valley, Victoria—Progress Report for the Seasons 1935-38," by G. A. H. Helson, M.Sc.

The work discussed was financed by the Canned Fruits Control Board and the Commonwealth Bank (from its Rural Credits Development Fund) and is a co-operative enterprise of the Council and the Victorian Department of Agriculture. The losses caused by the Oriental peach moth in the Goulburn Valley, Victoria, threaten the canned peach industry. Forty-four insecticides have been tested in the laboratory, the most promising of them being a white oil and a nicotine sulphate and bentonite mixture. Unfortunately, however, the only stages in the life history which can be reached by spray materials are the eggs and the newly-hatched larvæ. Field tests with a number of the most promising insecticides failed to give a satisfactory control of the pest because of the peculiar habits of the larvæ of the moth, the quickness of growth of the peach, particularly under irrigation, and the growth of the fruit in dense clusters. Five species of parasites have been introduced from the United States of America, and of these *Macrocentrus ancylivorus* has been recovered in the field.

Forthcoming Publications of the Council.

At the present time the following future publications of the Council are in the press:—

Bulletin No. .—"Radio Research Board—Report No. 14," by H. C. Webster, Ph.D., F.Inst.P., G. H. Munro, M.Sc., A.M.I.E.E., and A. J. Higgs, B.Sc.

Bulletin No. 125.—"A Soil Survey of Part of the Kerang District, Victoria," by J. G. Baldwin, B.Agr.Sc., G. H. Burvill, B.Sc.(Agric), and J. R. Freedman, B.Agr.Sc.

Bulletin No. 126.—"Investigations on Chilled Beef. Part I. Microbial Contamination acquired in the Meatworks," by W. A. Empey, B.V.Sc., and W. J. Scott, B.Agr.Sc.

Bulletin No. .—"Investigations on the problems of Salt Accumulation on a Mallee soil in the Murray Valley Irrigation Area," by J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.

Pamphlet No. 89.—"Needle Fusion of Pinus in Southern New South Wales. Second Progress Report 1937-38," by W. V. Ludbrook, B.Agr.Sc., Ph.D.

Pamphlet No. .—"Studies of the Physiology and Toxicology of Blowflies. I. The Development of a Synthetic Medium for Aseptic Cultivation of Larvæ of *Lucidia cuprina*," by F. G. Lennox, M.Sc., A.I.C.

H. J. Green, Government Printer, Melbourne.

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